



MARK 24

**MAINTENANCE
MANUAL**

AVIONICS DIVISION
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MAINTENANCE MANUAL



MARK 24



VHF COMMUNICATIONS TRANSCEIVER AND NAVIGATION RECEIVER

NARCO AVIONICS
DIVISION OF NARCO SCIENTIFIC INDUSTRIES
Fort Washington • Pennsylvania

CHANGE IN NOMENCLATURE

All future *narco* technical literature shall refer to frequency in "cycles per second" by using the term "Hertz." This nomenclature has been used in Europe in the past where the International Electrotechnical Commission (IEC) and other professional societies made the change. Recently, the Institute of Electrical and Electronic Engineers (IEEE) and the U.S. Bureau of Standards have changed their standards to make the usage world wide. From this date on, *narco* has changed to the new form as detailed below:

Frequency	Designation	
	Old Style	New Style
Cycles per second	CPS	Hz
Kilocycles per second	KCPS	kHz
Megacycles per second	mCPS	MHz
Gigacycles per second	gCPS	GHz

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SECTION 1

GENERAL INFORMATION

1-1. INTRODUCTION.

The *narco* Mark-24 Equipment combines in a single unit a 360 channel VHF communication transceiver and an independently operated 100 channel VHF Navigation Receiver. When mounted in an aircraft, the transceiver can provide two way voice communications and the navigation receiver can supply: (a) operational signals to a *narco* Model VOA-8/VOA-9 Navigation Converter; (b) frequency channel selection for a DME Interrogator (*narco* type UDI-2AR); (c) and if so desired, the MK-24 can control a Glide Slope Receiver (*narco* UGR-2). Refer to Figure 1-1 for the interconnecting equipment. The Mark-24 Equipment, which is fully transistorized, requires a minimum of operating power from the aircraft electrical system.

1-2. FUNCTIONAL DESCRIPTION.**1-3. Communication Transceiver.**

The communication transceiver is comprised of a crystal controlled dual conversion superheterodyne receiver and a crystal controlled transmitter connected for simplex transmission of voice signals. The receiver utilizes two crystal oscillators for the dual conversion process: two channel selector switches connect the required crystals and tuned circuits for operation on each communication channel. The operating frequency is obtained from two crystal oscillators, using frequency synthesis techniques. The two crystal controlled signals are mixed and the desired heterodyning signal is obtained by tuning the output to this frequency. A squelch control is used to suppress background noises when using voice communications.

The two channel-selector controls perform the switching function for all crystals and all tuned circuits in increments of 1MHz (mc) and 0.05MHz (mc). The transmit/receive relay, which is activated by the press-to-talk microphone switch, transfers the antenna and audio amplifier from the receiver to the transmitter. The audio amplifier serves as a modulator in the transmitter and an audio amplifier in the receiver.

1-4. Navigation Receiver.

The navigation receiver is a crystal controlled dual conversion superheterodyne receiver which provides code, voice, and OMNI/LOCALIZER navigation signals. The two channel-selector controls perform the switching function for all crystals and all tuned circuits in increments of 1MHz (mc) and 0.1MHz (mc). Additional switch decks control the operation of a navigation converter, a glide slope receiver, and DME. Voice signals and navigation signals may be received simultaneously with no interference between the two: the IDENT switch, located on the front panel removes the

1020Hz (cps) identification signal from the audio output. In a navigation system, the receiver performs the following: provides the OMNI/LOC signal to the navigation converter; provides the signal to switch the navigation converter from OMNI to LOCALIZER operation; provides the control signal to a glide slope receiver for paired channel operation; provides channel control signals to a DME; and provides reception of voice and code signals from the navigation transmitting station. All *narco* navigation equipment is compatible for operation in this type of complete ILS configuration.

1-5. MECHANICAL DESCRIPTION.

The *narco* Mark-24 Equipment is comprised of a single unit and mounting tray. The mounting tray is equipped with the electrical connectors and permits rapid insertion or removal of the unit from the aircraft. The communication transceiver front panel controls and associated circuits are located on the left side of the unit and the navigation receiver is located on the right side. A longitudinal partition inside the unit separates the two spaces. The rear surface contains a 50 pin electrical connector, coax connector and the guide pin for installation in the mounting tray.

Since the NAV receiver and COM transceiver tuning are similar, the description below will apply to both tuning units. The tuning controls (channel selector) are comprised of two multi-deck rotary selector switches geared to a single multi-digit frequency indicator. The gear train utilizes a plastic gear and cam detent for indexing of the switch contacts. The left control is geared to activate the first three digits, indicating the frequency in MHz (mc). The right control is geared to actuate the fractional MHz (mc) digits at the right. The NAV readout is indicated in 0.1MHz (mc) and the COM readout is in 0.05MHz (mc) steps. The multideck rotary switches are constructed so as to permit removal of the shaft for replacement of a defective switch deck. The quartz crystal decks are enclosed in sealed metal shielding units. All printed circuit assemblies have slack cable connections that permit removal of the assembly and tilting for access to the soldered components.

The Mark-24 is secured to the mounting tray as follows: the guide pin on the rear panel is inserted into a grommet at the rear of the tray to align the two electrical connectors at the rear of the unit; the two locating studs (left and right side behind the front panel) engage with a notch in each side of the mounting tray; and a latch operated by a screwdriver inserted into an opening in the front panel, secures the Mark-24 in the tray. Figures 1-2 shows the guide pin and mating connectors.

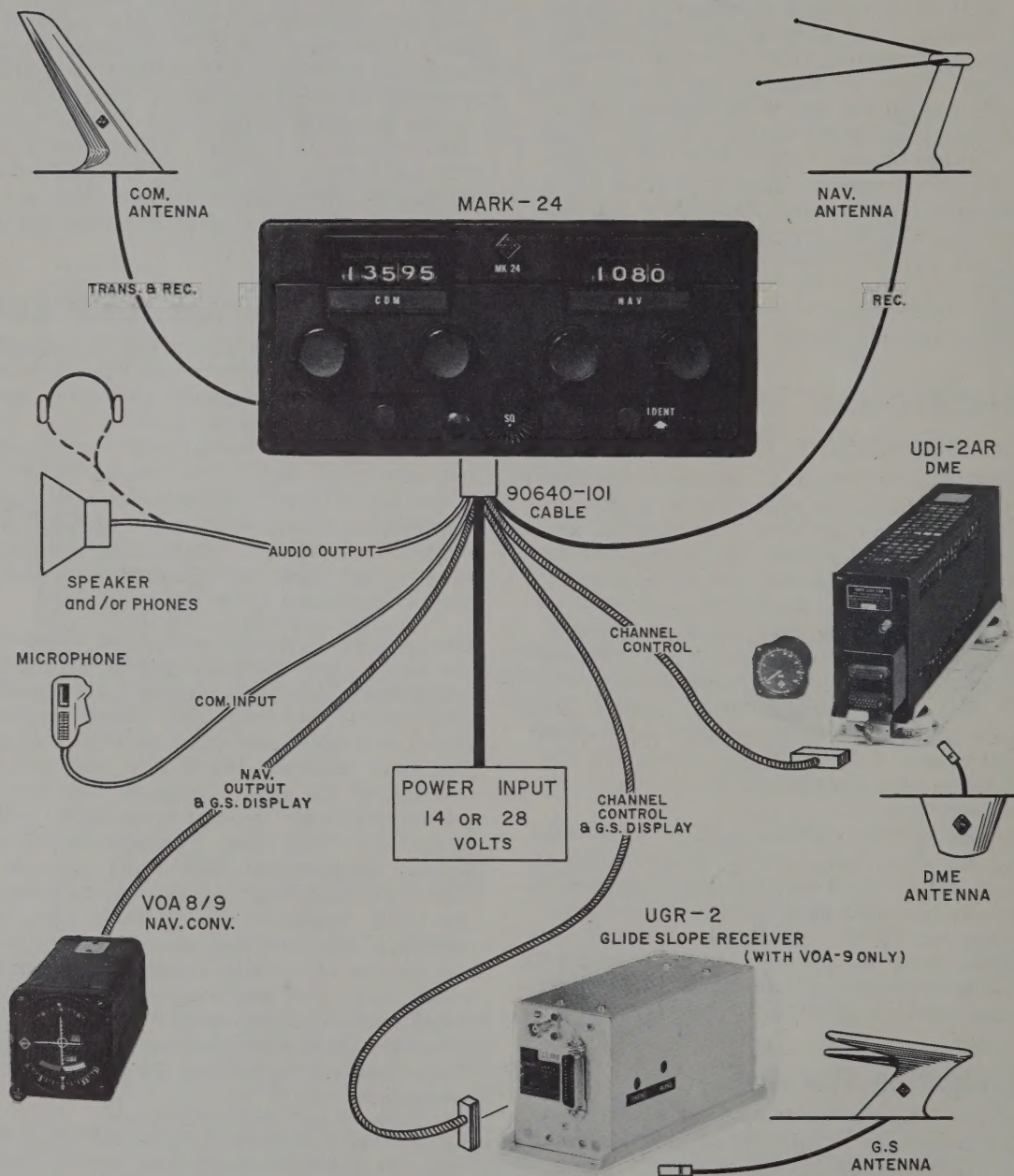


FIGURE 1-1. *narco* MARK-24 NAV/COM SYSTEM

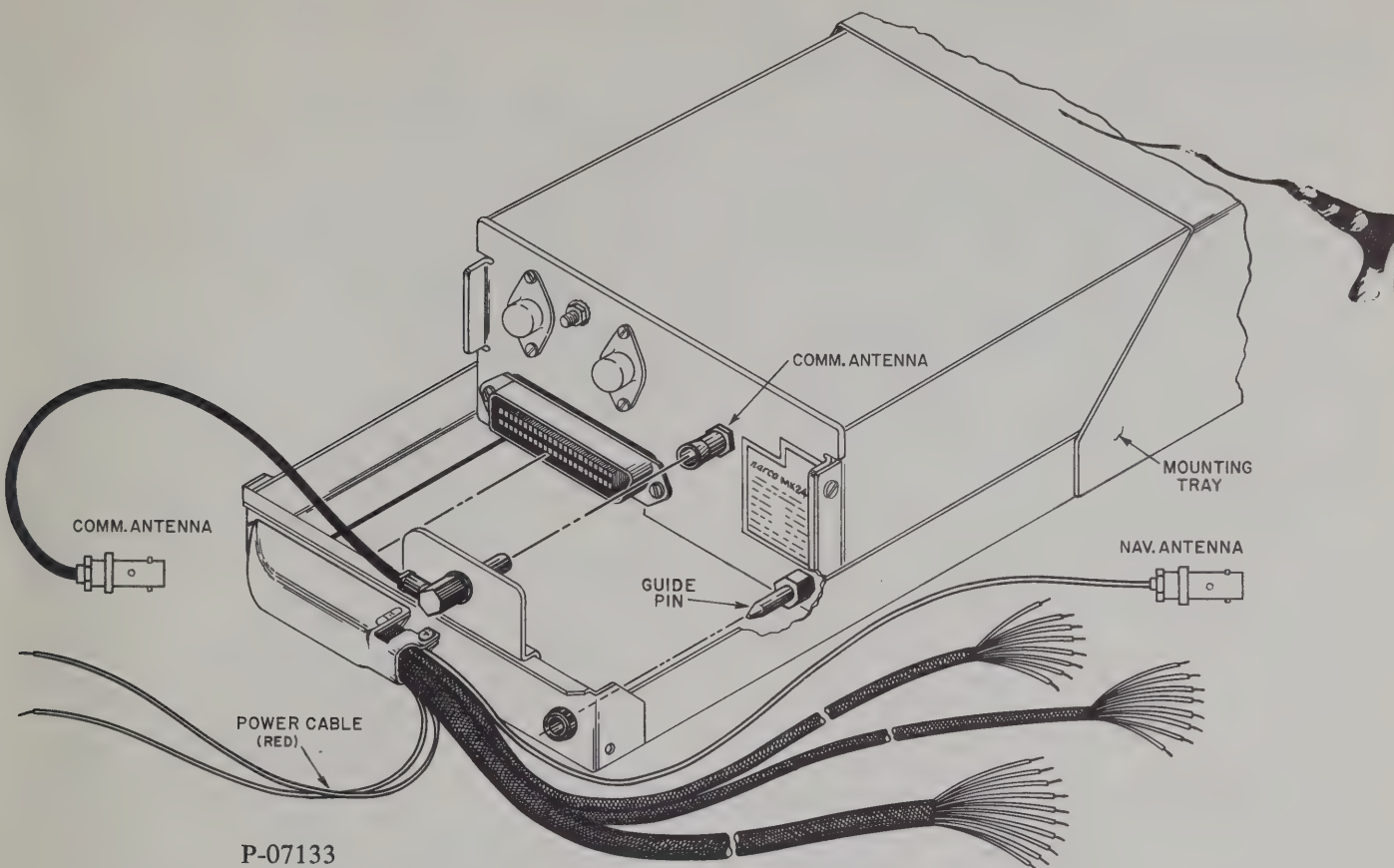


FIGURE 1-2. narco MARK-24, AND MOUNTING TRAY MATING

1-6. SPECIFICATIONS.

1-7. Communication Transceiver.

Frequency Range, Domestic Equipment:

118.00 thru 135.95MHz(mc)

Frequency Range, Export Equipment:

117.00 thru 135.95MHz(mc)

A. Communication Transmitter.

Power Output:

Nominal 6 watts into 50 ohms.

Sidetone:

50 milliwatts to headphone circuit.

Modulation:

At start of clipping, 90% nominal, 85% minimum.

Microphone:

Carbon, noise-cancelling carbon (low impedance), or dynamic with transistor pre-amp to be used.

Duty Cycle:

Maximum 20% (1 minute ON 4 minutes OFF)

B. Communication Receiver.

Sensitivity:

1.5 microvolts maximum for 6 db signal + noise to noise ratio.

Overall Selectivity:

6 db (nose), 32kHz(kc) minimum bandwidth.

60 db (skirt), 68kHz(kc) maximum bandwidth.

Image Rejection:

At least 60 db.

AVC:

5 db from 10 to 10,000 microvolts.

Frequency Response:

Within 6 db, 350 to 2500Hz(cps).

Audio Output:

5 watts minimum.

1-8. Navigation Receiver.

Frequency Range:

108.0 thru 117.9MHz(mc)

Sensitivity:

1.0 microvolt for 6 db signal + noise to noise ratio.

Overall Selectivity:

6 db (nose), 42kHz (kc) minimum bandwidth.

60 db (skirt), 158kHz (kc) maximum bandwidth.

Image Rejection:

At least 65 db.

AVC:

4 db from 10 to 10,000 microvolts.

Frequency Response:

Within 6 db, 350 to 2500Hz(kc).

Audio Output:

5 watts minimum.

IDENT Filter:

Tone rejection, 15 db minimum, 1020Hz (cps).

1-9. Overall Physical and Electrical.

Size:

See Figure 2-1.

Weight:

Unit Assembly with covers, 8.1 lbs.

Mounting Tray with Connectors and Cables 1.4 lbs. (0.5 lbs. for Mounting Tray with COMM R.F. Connector Assembly.)

Power Required:

At 13.75 Volts,

Receive 1.50 amps with 5 watts audio output.
Transmit 4.00 amps.

At 27.5 Volts,

Receive 1.0 amps, with 5 watts audio output.
Transmit 3.00 amps.

1-10. TSO Compliance.

Meets applicable portions of:

TSO		ENV. CAT.
		C
C36b		— ACAA AE
		D
		B
C37b	— CLASS II —	— ACAA AE
		D
		B
C38b		— ACAA AE
		D
		C
C40a		— ACAA AE
		D

1-11. UNITS AND ACCESSORIES SUPPLIED.

1. **narco** Mark-24 Unit Assembly, with top and bottom covers, and COM Transceiver frequency range as ordered:

- a. Domestic Equipment: 360 Channels.
- b. Export Equipment: 380 Channels.

2. Mounting Tray and COM Antenna Connector Assembly. **narco** P/N P-54650-101

3. Connector and Cable Assembly for all external connections except COM Antenna. **narco** P/N P-90640-101

NOTE: COM Antenna Connector is on an 8 inch coax cable on the Mounting Tray Item 2, above.

4. COM Antenna Connector (BNC Type).
Mates with connector on 8 inch coax cable on the Mounting Tray, item 2 above.
narco P/N K-41152-1

5. NAV Antenna Connector (BNC Type).

Mates with connector on a 12 inch small diameter coax cable extending from the connector under item 3, above.

narco P/N K-41152-1

1-12. ACCESSORIES REQUIRED, But Not Supplied.

1. Communication and Navigation Antennas and Cables.

Mark-24 TSO (Technical Standard Order) compliance testing has been accomplished to FAA Standards.

To ensure complete FAA Part 37 TSO compliance as applied to Air Carrier operations, the Mark-24 must be used with Communication and Navigation antennas meeting TSO's C-36b, C-37b, C-38b and C-40a.

NOTE

When TSO compliance is not required for the installation the **narco** VRP-15A Pedestal Antenna, or the **narco** VRP-37 Fin Mounting Antenna is suggested.

2. Headphones and Speaker.

- a. Headphones: Low impedance type, 300 to 1000 ohms.
- b. Loud Speaker: Voice coil impedance 3 to 6 ohms nominal.

Both headphones and speaker may be used if desired.

3. Brackets for Mounting Tray Installation.

1-13. OPTIONAL UNITS AND ACCESSORIES AVAILABLE.

A. OMNI Converters.

1. **narco** VOA-8 Navigation Converter, for OMNI or LOCALIZER Course deviation indication.
2. **narco** VOA-9 Navigation Converter, with Glide Slope Indicator, for OMNI, LOCALIZER and GLIDE SLOPE deviation indication.

B. Glide Slope Receiver.

narco UGR-2, 20 channel model.

C. DME Interrogator.

1. **narco** UDI-2AR, remote controlled model.
2. Navigation Antenna Coupler, **narco** type VP-15.
3. Junction Block, Control Cable Termination, **narco** Part No. 01090-101.

SECTION 2 INSTALLATION

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2-1. INTRODUCTION.

This section provides information necessary for the installation of the Mark-24 in an aircraft. The instructions given below cover mechanical, electrical, and antenna installation procedures.

The *narco* Mark-24 Communication Transceiver and Navigation Receiver is comprised of a single unit mounted on a tray located in the instrument panel of the aircraft. Interconnecting cables may be purchased from *narco* for the specific installation or may be fabricated to provide signal and power to any additional communication and/or navigation equipment. The tray assembly is permanently installed in the aircraft to facilitate rapid installation and removal of the unit. A guide pin, located at the lower left corner of the rear panel, aligns the two electrical connectors at the rear of the unit with two connectors on the tray assembly. A latch operated by a screwdriver inserted into the lower front panel performs the final mating of both rear connectors: locating studs at each side of the front panel index the unit into the proper vertical location and form a back stop for the unit.

The unit may be removed from the instrument panel by loosening the latch that is recessed in the front panel; the electrical cables are automatically disconnected when the unit is removed.

2-2. MECHANICAL INSTALLATION.

The *narco* Mark-24 Equipment is essentially a single unit intended to be mounted in a location convenient for direct manual operation by the pilot. The original installation involves mounting of the tray which supports the unit assembly and makes all external connections. After installation of the tray, installation and removal of the unit involves only the use of a flat blade screwdriver to operate the latch accessible through a hole in the front panel.

A. Tray Mounting.

The size of the cutout required in an aircraft instrument panel, to accommodate the tray mounting, is the same as the height and width of the front trim panel. For details see Figure 2-1.

B. Mechanical Support and Grounding.

1. Mechanical Support.

Mounting brackets for the tray installation are not supplied because the requirements vary widely, depending on the particular aircraft and the equipment location.

It is intended that the tray be fastened securely near its front, with brackets attached either at the sides or at the top and bottom. Holes and bosses

are provided for the purpose. The height of the screw heads holding the front of the tray must be no greater than 7/64" (equal to #8 binding head). In addition to support at the front, it is necessary that the rear of the tray assembly be supported at both sides by suitable brackets. Holes are provided on each side for this purpose.

2. Grounding.

It is important that a good permanent electrical ground be made to the metal airframe and in turn to the electrical system ground. The ground can be provided by the rear support straps, if proper precautions are taken to make a good electrical connection.

All paint, protective coatings and insulation must be removed where the connection is made.

3. Mounting Brackets.

Suitable mounting brackets for a particular installation can be readily fabricated from ordinary aluminum sheet or angle stock.

2-3. ELECTRICAL INSTALLATION.

As noted in the introduction, the *narco* Mark-24 Equipment is essentially a single unit to which all electrical connections are made automatically, when the unit is inserted and properly seated in its mounting tray. Refer to Figure 2-2 and 2-3 for connections.

A. Tray Connections.

The mounting tray has two connectors at the rear which mate with corresponding connectors on the unit assembly. The connectors are:

- COM Transceiver Antenna Connector.
- Multi-circuit connector (50 circuits) which accommodates all other electrical connections, including the NAV Antenna and the primary DC power.

B. COM Transceiver Antenna Connector.

The mating connector on the tray has an 8 inch length of RG-58A/U cable, and female BNC connector attached to it for connection with the cable to the COM Antenna.

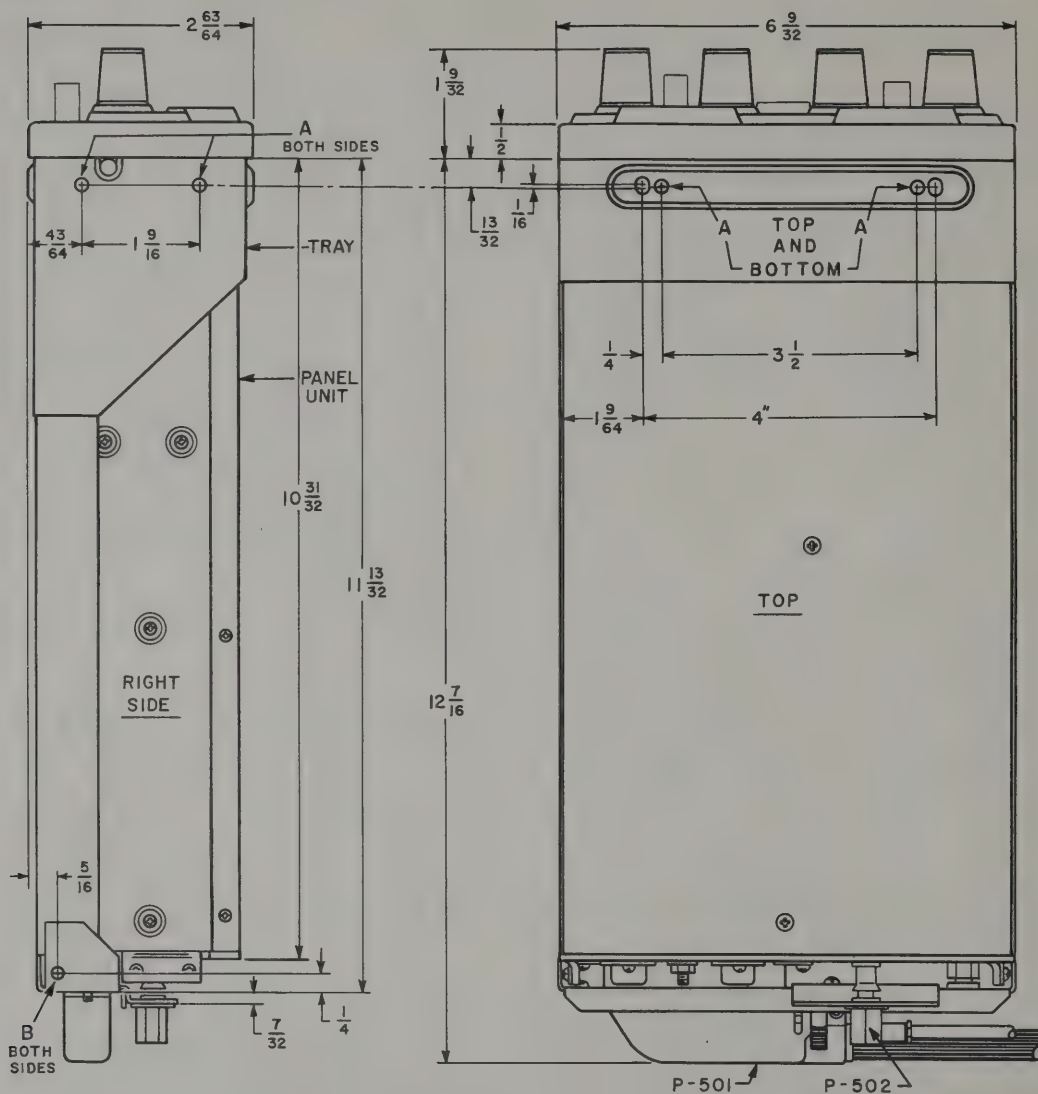
C. Multi-Circuit Connector (50 Circuits).

This connector has wires and cables extending in five different branches. They are:

- NAV Receiver Antenna.
- Input Power, + D.C.
- Audio Circuits.
- Navigation Converter Circuits.
- Glide Slope Receiver and DME Interrogator Control Circuits.

D. NAV Receiver Antenna Cable.

This is a small diameter COAX cable about 12"

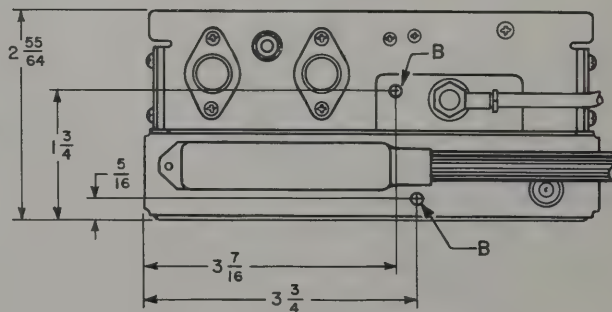


A-CLEARANCE HOLE FOR No.8 MACHINE SCREW, FOR MECHANICAL SUPPORT.

B-CLEARANCE HOLE FOR No.6 MACHINE SCREW, FOR MECHANICAL SUPPORT.

NOTE-1
TRAY IS INTENDED TO BE MOUNTED PERMANENTLY IN THE AIRCRAFT.

NOTE-2
PANEL UNIT IS HELD IN TRAY BY A LATCH ACCESSIBLE THRU A HOLE IN THE FRONT PANEL.



P-07131

FIGURE 2-1. MECHANICAL INSTALLATION

long. It has on the end a female BNC connector for connection with the cable to the NAV Antenna.

E. Input Power, + D.C.

Two RED #22 wires (connected in parallel) about 14 inches long, extend directly from the Multi-circuit connector cover. They are for connection to the primary + DC power, a nominal 14 or 28 Volts, depending on the unit internal connections.

F. Audio Circuits.

An 11 wire cable, 6 feet long, having color/numbered wires, is provided for connection to the headphones, loud-speaker, microphone, and external audio sources, as well as making certain internal interconnection. See the Interconnection Diagram, Figures 2-2 and 2-9.

G. Navigation Converter Circuits.

An 11 wire cable, 4 feet long, having color/numbered wires, is provided for connection to navigation converters such as *narco* VOA-8 or VOA-9. For details see Figures 2-5, 2-6, and 2-7 and the Interconnection Diagram, Figures 2-2 and 2-9.

H. Glide Slope Receiver and DME Interrogator Control Circuits.

A 32 wire cable, 6 feet long, having color/numbered wires, is provided for the control of a glide slope receiver such as the *narco* UGR-1A, and a DME Interrogator such as the *narco* UDI-2AR. For details see the appropriate manuals and the Interconnection Diagram, Figures 2-2 and 2-9.

2-4. PRIMARY POWER.

A. Power Source.

The *narco* Mark-24 Equipment is designed to operate from a nominal 14 or 28 volt aircraft dc power source. Current requirements are given in the specifications, Paragraph 1-9.

B. Circuit and Equipment Protection.

The primary dc circuit to the equipment should be protected with a fuse or other protective device rated as follows:

- 7.5 amps for a nominal 14 volt installation.
- 5 amps for a nominal 28 volt installation.

C. Voltage Conversion.

The *narco* Mark-24 Equipment may be operated on either a nominal 14 or 28 volt dc supply, depending on the internal connections. For voltage change connections See Figure 2-8 and refer to Paragraph 5-27 for adjustment of the transmitter modulation.

D. Pilot Light Connections.

The pilot light wire is available in the 32 wire cable mentioned under 2-3, H above. It may be connected directly to the aircraft dimmer system or connected to switched A+ available in the same cable branch. For details, see the Interconnection Diagram, Figure 2-2. The pilot light bulbs do not require changing as a part of the voltage conversion procedure.

2-5. ANTENNA REQUIREMENTS.

A. Communication.

Satisfactory reception and transmission requires a

vertically polarized antenna having a nominal impedance of 50 ohms and a low Voltage Standing Wave Ratio (VSWR) over the frequency range to be used.

Only one antenna is necessary for communication, since antenna changeover switching is built into the unit. The communication antenna should be mounted on as large and flat a metallic surface as possible. A suitable surface is often found directly in front of the windshield in fabric-covered ships, or at the center of the cabin roof in metal ships. If no such surface exists, a suitable ground plane may be provided by cementing metal foil on the inside surface of the non-metallic structure. The communication antenna should be located at least 12 inches from other objects on the surface of the aircraft.

B. Navigation.

In any VHF installation, the type of antenna and its location are extremely important. Only with the proper antenna in the best location can the full range and accuracy of the VHF Omni Range system be realized. In installations where an Omni Converter is to be used with the *narco* Mark-24 navigation receiver a **horizontally polarized antenna is absolutely necessary.** A quarter-wave unipole, frequently used for communication, is definitely not satisfactory, although it may appear to be when tried. While vertically polarized components of the omni signal are not normally radiated by the ground station, they are frequently produced by reflections. Therefore, a vertical antenna may receive strong signals not coming directly from the ground station, giving very unreliable bearing information.

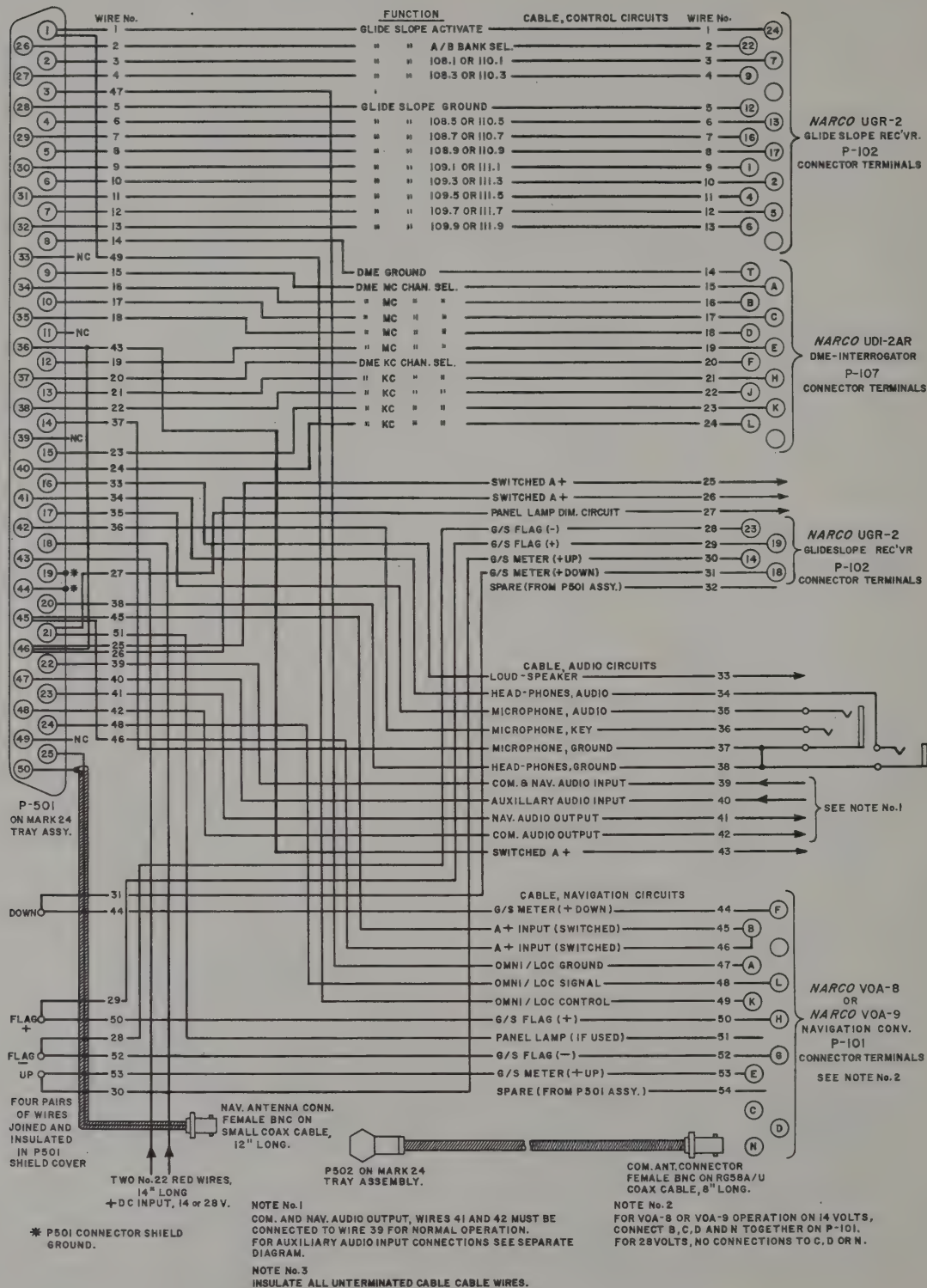
If the Navigation Receiver in the *narco* Mark-24 Equipment is to be used for communication only, it may be connected to any communication type antenna which is not being used for transmission.

The RF cable should be RG-58A/U of as short a length as is practical. All bends should have at least a 6" radius.

C. Important Antenna Information.

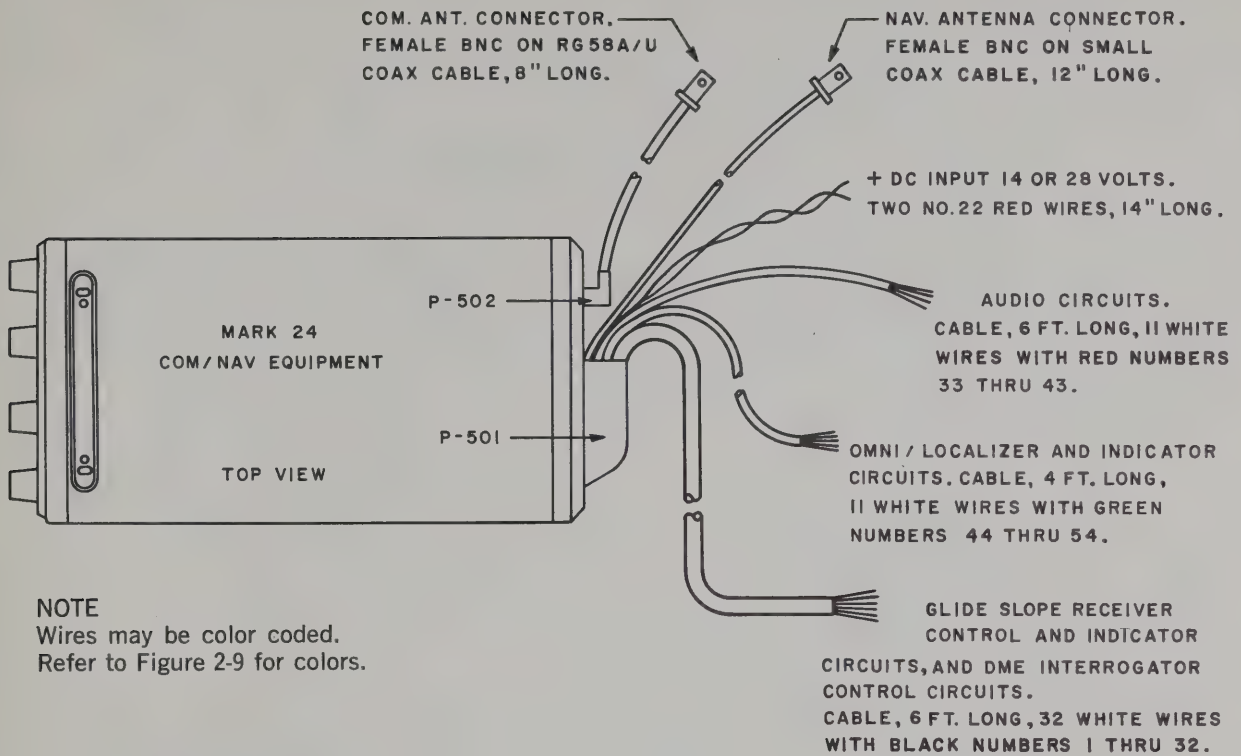
For best navigation receiver performance while transmitting, the NAV and COM antennas should be well isolated from each other. The navigation antenna should always be located well away from the engine (s) and propeller(s), and at least two feet from other antennas or wires. A wire, such as an ADF sense antenna, running near the navigation and transmitting antenna can couple transmitter energy into the NAV receiver. A good arrangement is to use a fin-mounting navigation antenna such as a VRP-37 on the vertical stabilizer, and to mount the communication antenna as far forward as possible.

Transmitting on frequencies within about one megacycle of a desired OMNI frequency will reduce NAV receiver sensitivity. The reduction in sensitivity becomes less as the transmitter frequency is separated more from the OMNI frequency. With frequency separation



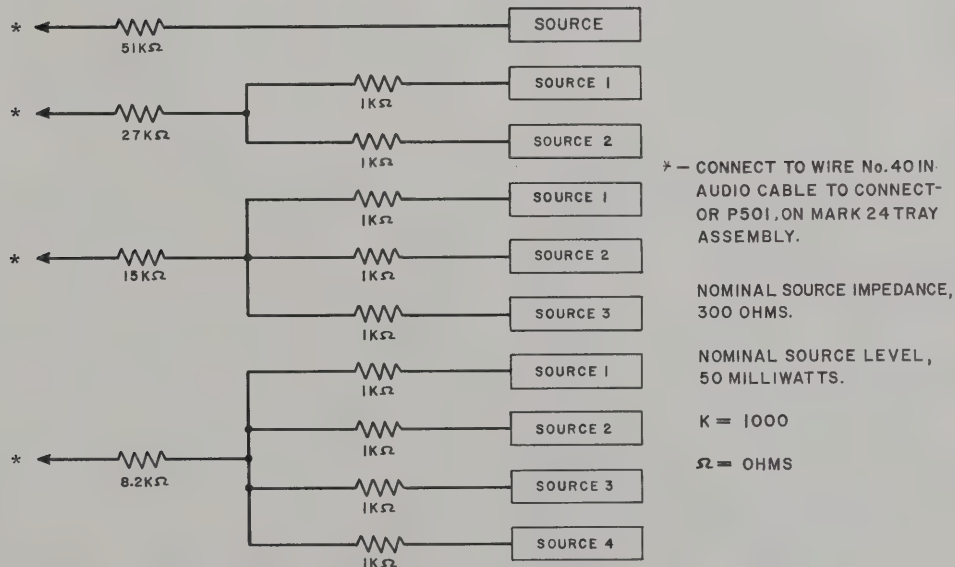
T-07135

FIGURE 2-2. MARK-24 MULTI-CIRCUIT CABLE CONNECTIONS



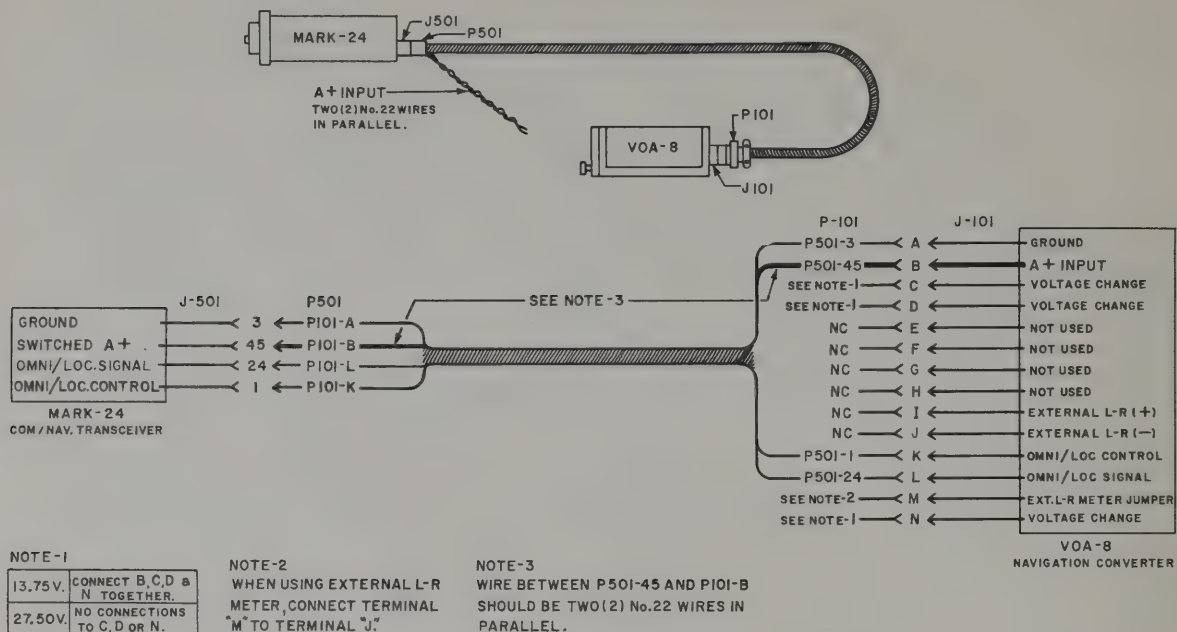
P-07134

FIGURE 2-4. AUXILIARY AUDIO INPUTS



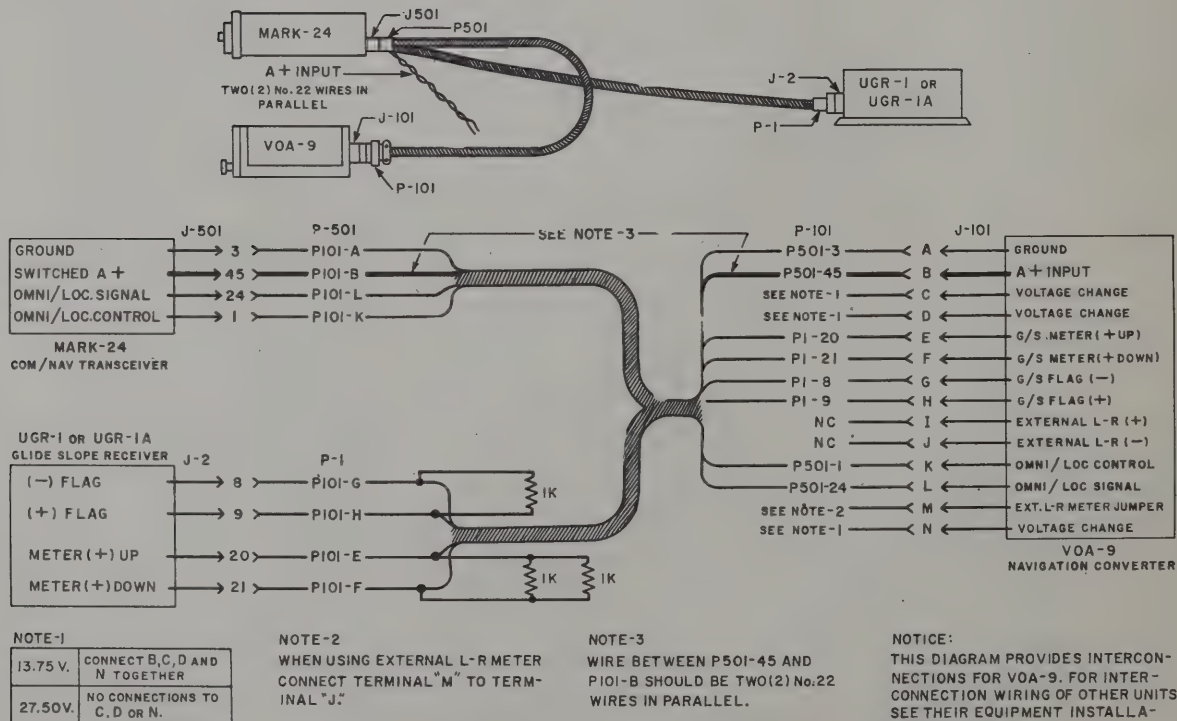
M-07136

FIGURE 2-4. AUDIO DISTRIBUTION



T-07130

FIGURE 2-5. INTERCONNECTION DIAGRAM MARK-24 AND VOA-8



P-07129

FIGURE 2-6. INTERCONNECTION DIAGRAM MARK-24, VOA-9 AND UGR-1A

greater than about one megahertz (mc), little desensitization will be observed.

Keying or unkeying the transmitter may produce a transient in the NAV receiver and the OMNI converter. This transient would be observed as a brief jump of the OMNI indicator needle. An autopilot coupled to the OMNI converter will not respond to this transient due to the long time constant in the coupler circuits.

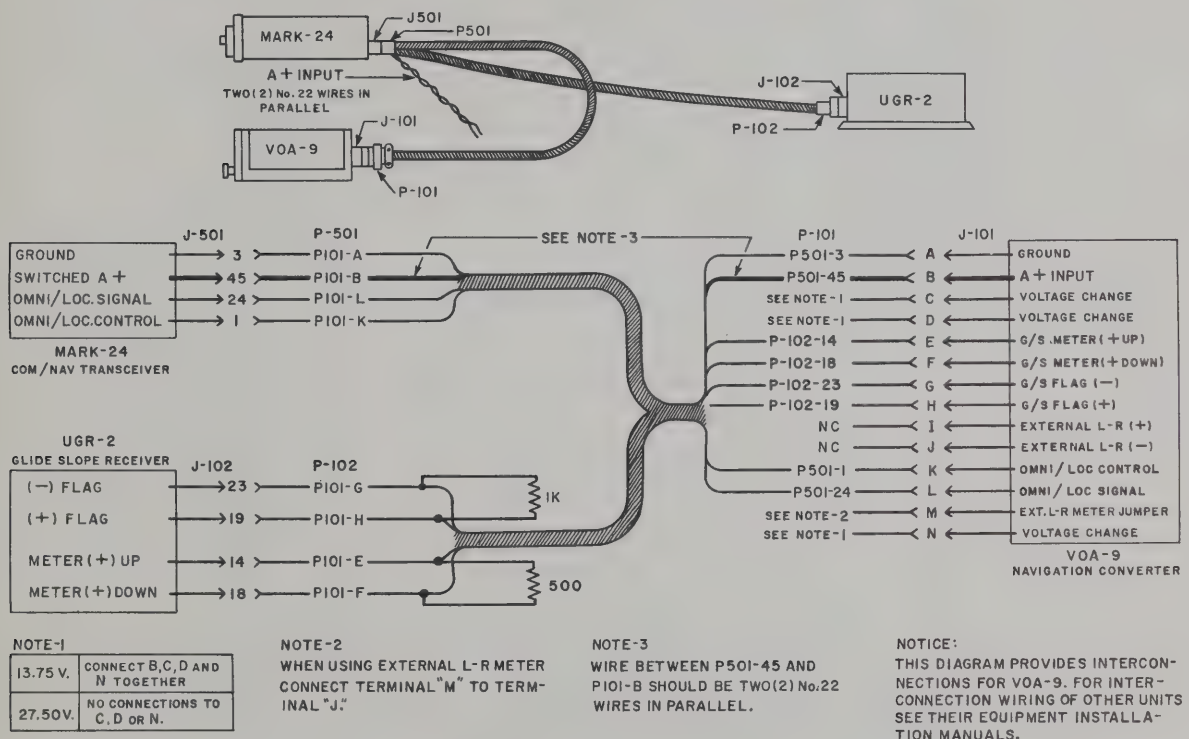
2-6. POST-INSTALLATION CHECKOUT.

After the installation has been completed, it should be operated on the ground, with all normal power turned

on and the engine(s) running. The receivers should be checked for proper operation by channeling to available signals. A ground check of the transmitter should be made to determine output and audio quality. This may be done by contacting the control tower or any other communication facility.

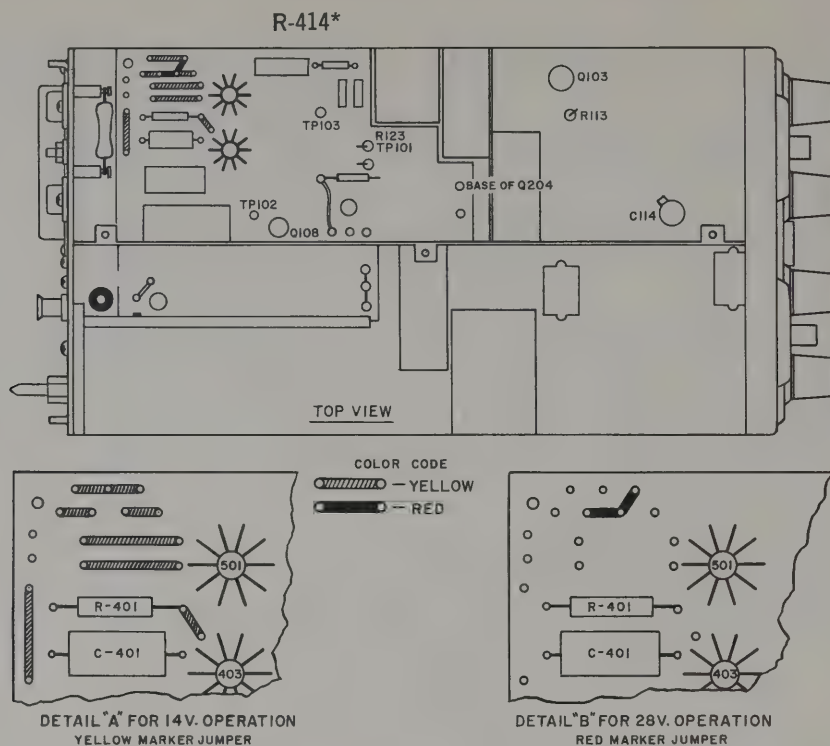
CAUTION

When making tests on the COM Receiver with a Signal Generator connected to the COM antenna connector, do not close the microphone switch or activate the transmitter in any way. This is to protect the signal generator from transmitter output power.



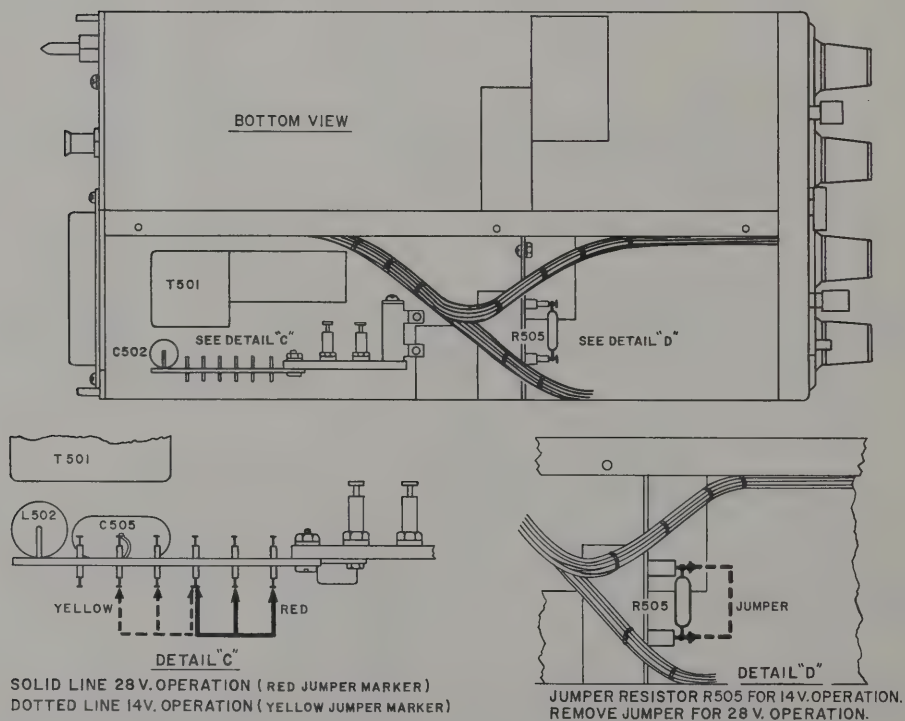
P-07182

FIGURE 2-7. INTERCONNECTION DIAGRAM MARK-24, VOA-9 AND UGR-2



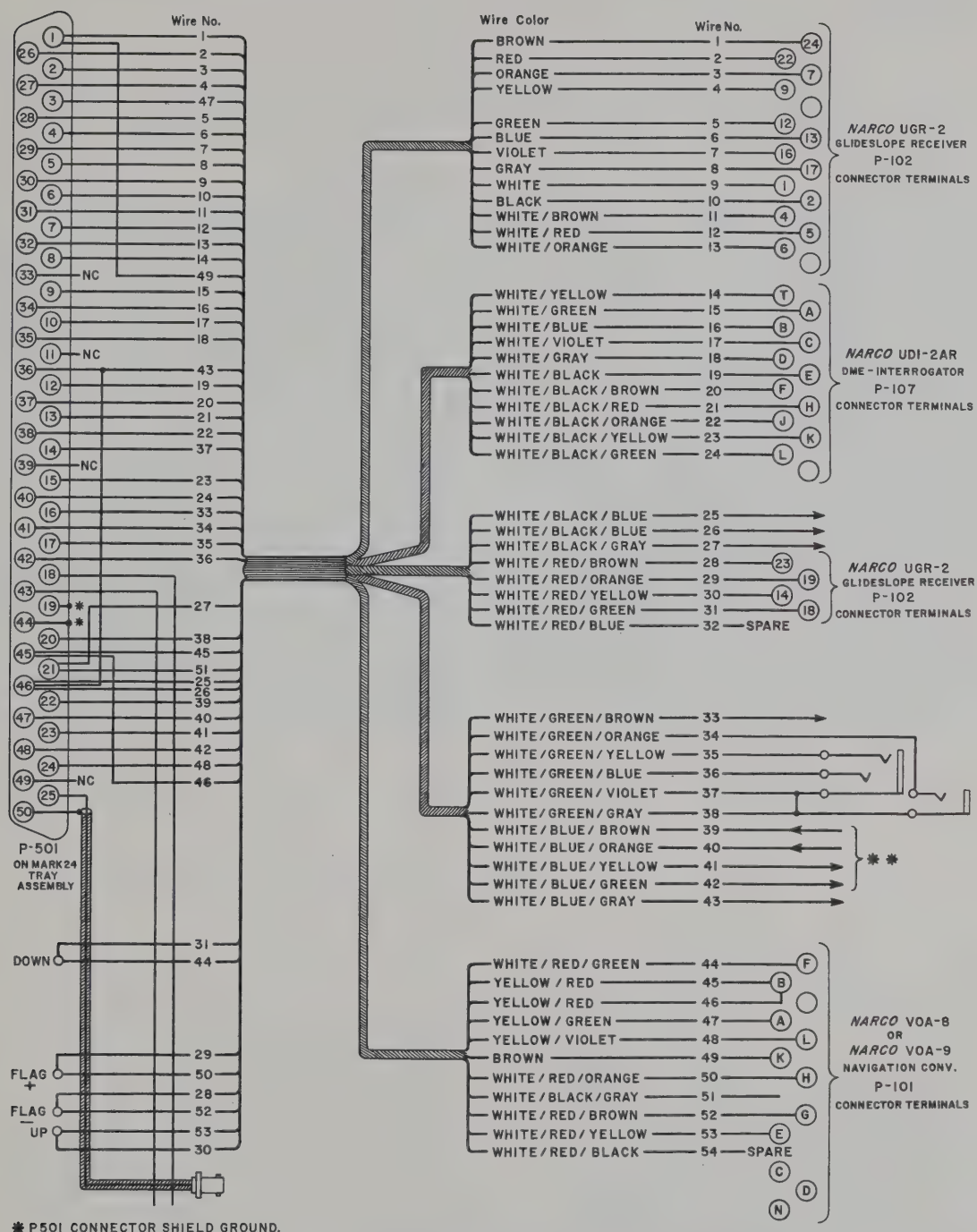
P-07133-1

*Refer to Paragraph 5-27 for adjustment of R-414



P-07133-2

FIGURE 2-8. VOLTAGE CHANGEOVER, OPERATION ON 14 OR 28V DC



NOTE: REFER TO FIGURE 2-2 FOR WIRE FUNCTIONS.

T-07237

FIGURE 2-9. INTERCONNECTION DRAWING SHOWING WIRE COLOR CODE

SECTION 3 OPERATION

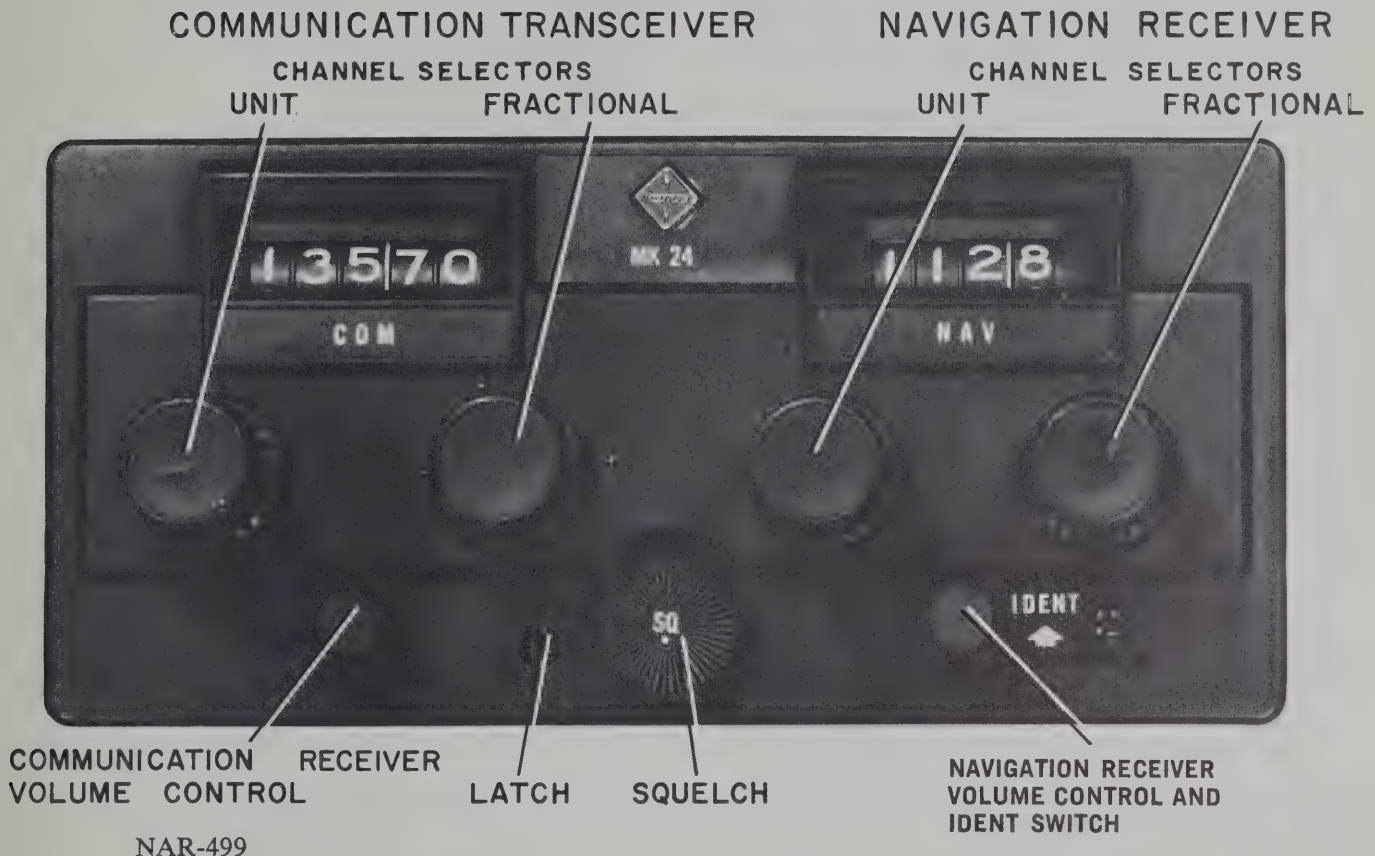


FIGURE 3-1. MARK-24 FRONT PANEL VIEW SHOWING CONTROLS AND INDICATORS

3-1. INTRODUCTION.

This section contains instructions for the operation of each control on the Mark-24 Communication Transceiver and Navigation Receiver. Operating instructions are given only to the extent of operation following installation, operation during checkout, and operation during troubleshooting. For operational procedures please refer to the Mark-24 Operator's Manual, and the various publications published by the FAA.

All operating controls are located on the front panel in two functional groups. The communication transceiver controls and channel indicators are located on the left half and navigation receiver controls are located on the right half of the front panel. The communication receiver squelch control is located at the center of the panel near the bottom edge.

3-2. COMMUNICATION TRANSCEIVER.

A. Channel Selection.

Since the Communication (COM) transceiver tuning is common to the receiver and transmitter, one set of controls serves this dual function. Two controls, a unit switch and a fractional unit switch, set the frequency of operation and a five digit counter provides a digital display of the frequency tuned. The channels have 50kHz (kc) separation. The extreme left knob controls the unit selector 1.0MHz (mc) and the other knob controls the .05MHz (mc) fractional unit selector.

B. COM Indicator.

The COM channel indicator (frequency readout) is a five digit display that indicates the operating

frequency of the COM Transceiver. The five digit display is geared to the two channel selector knobs to indicate the frequency of the operational channel.

C. Volume Control/Power Switch

The small knob near the bottom of the panel, between the two channel selector knobs, controls the volume of the COM receiver. When set to the extreme counterclockwise position, a switch on the volume control turns off the combined power to the transceiver and the Navigation Receiver.

D. Squelch Control.

The Squelch Control is a flat disc shaped knob located at the center of the front panel, near the bottom. The squelch control is used to suppress noise during a pause in voice communication.

CAUTION

The squelch action decreases the sensitivity of the communication receiver when receiving weak signals. Use a minimum of squelch at all times.

E. Transmitter Control.

The transmitting function of the communication transceiver is controlled by the Press-to-talk switch on the microphone. Since the frequency control described in paragraph 3-2,B is common to the receiver and transmitter, the operating frequency of both is identical. The microphone switch activates a relay which transfers the antenna and power connections to the transmitter and disconnects the communication receiver during transmission of voice communications. The navigation receiver remains operational during transmission.

3-3. NAVIGATION RECEIVER.

A. Channel Selector (NAV)

The Navigation Receiver is tuned by a pair of controls located at the right side of the panel below

the NAV channel indicator. Two controls, a whole unit switch and a fractional unit switch, set the frequency and a four digit counter provides a digital display of the frequency or channel tuned. Each channel is 100Kc wide (0.1 Mc). The left knob controls the whole unit selector (1.0MHz) and the extreme right knob controls the fractional unit selector (0.1MHz).

B. NAV Channel Indicator.

The NAV channel (frequency readout) indicator is a four digit display that indicates the operating frequency of the navigation receiver. The four digit display is geared to the shafts of the two channel selector knobs.

C. Volume Control/IDENT Switch.

The Volume Control/IDENT Switch, located below the navigation channel selector knobs, is comprised of a rotary volume control and a lever switch concentrically mounted. The volume control determines the audio output level from the Navigation Receiver. The IDENT switch operates a 1020Hz (cps) tone filter to eliminate the OMNI/LOC station identification code from voice reception on the Navigation channels.

D. External Switching

The channel selector switches have additional switching capabilities for controlling navigation equipment for OMNI/LOC operation. When the channel selector is set to localizer channels, odd fractional units 108.1 thru 111.9MHz (mc), a Navigation Converter connected to the receiver will be switched to LOCALIZER operation. The even tenths MHz (mc) channels operate the converter in the OMNI mode. In addition, a group of contacts select the operating channels of a glide slope receiver operating on channels in the UHF range. The channels are selected as a pair for LOCALIZER/GLIDE SLOPE indications. Additional switching circuits permit channel selection for DME.

SECTION 4
CIRCUIT DESCRIPTION**4-1. FUNCTIONAL DESCRIPTION.**

The *narco* Mark-24 Equipment is comprised of a VHF Communications Transceiver and a VHF Navigation Receiver in a single case suitable for flush mounting on an aircraft instrument panel. Separate connectors are provided for communication and navigation antennas. In addition, front panel switching makes the Mark-24 compatible with *narco* DME and ILS equipments.

The communications transceiver is comprised of a dual conversion superheterodyne receiver and rf transmitter that are controlled simultaneously by the channel selector to provide simplex communications on 360 crystal controlled channels within the 118.00 to 135.95MHz (mc) range. The transmitter and receiver operate separately; however, the audio amplifier serves as the amplifier for the receiver and the modulator for the transmitter, and the crystal oscillators are common to the receiver and transmitter. Two separate front panel selector controls, the unit control and the fractional unit control, permit selection of the operating frequency in 50kHz (kc) increments. Both controls must be used to select the desired operating frequency.

The navigation receiver is a crystal controlled superheterodyne receiver for the reception of navigation information on any of 100 crystal controlled channels within the 108.0 to 117.9MHz (mc) range. Two separate front panel selector switches, the unit switch and the fractional unit switch, permit selection of the operating frequencies in 100kHz(kc) increments.

4-2. COMMUNICATIONS TRANSCEIVER, RECEIVER SECTION.**4-3. Introduction.**

The Mark-24 communications receiver has 360 crystal controlled channels spaced at 50kHz (kc) intervals within the 118.00 to 135.95MHz (mc) range. The export model has 380 channels within the 117.00 to 135.95MHz (mc) range.

The double conversion superheterodyne receiver utilizes two crystal controlled oscillators with rotary selectors transferring the crystals and tuned circuits to: (1) mix the second harmonic of the HFO with the received signal to obtain the first intermediate freq. (HFIF), and (2) mix the LFO with the HFIF to obtain the second intermediate freq. (LFIF). The two oscillators are common to both sections of the transceiver, since they are used in a frequency synthesis circuit to generate the transmitter rf carrier frequency for simplex operation. The audio circuits include squelch, a noise limiter and preamplifier. The audio power amplifier/modulator is common to the receiver and transmitter.

4-4. R.F. Amplifier (Q-201).

The rf communication signal, which is received by the

vertically polarized antenna, is connected into the Mark-24 through antenna connector J-502. A series resonant trap (L-219, C-272) is connected from J-502 to ground, to prevent interference from broadcast stations operating in the FM band. Relay K-501, the transmit/receive relay serves to connect this signal to the tuned input network of Q-201, or when the press-to-talk switch is activated the antenna is connected to the transmitter output.

The rf input signal is connected to C-201 and C-202 to match the antenna impedance; then to C-203 and C-205 to match the base input impedance of Q-201. The total equivalent capacitance of the above capacitors plus C-204 resonates with L-201 at 135MHz (mc). When the inductance of L-202 is varied by the unit frequency selector control, the circuit is tracked at all frequencies between 117MHz (mc) and 135MHz (mc). The base of Q-201 is connected to the AGC buss through the decoupling network, R-202 and C-206. In addition, CR-201 is connected to the base of Q-201, providing limiting of high amplitude pulses that would otherwise damage the transistor. The output of Q-201 is connected to a tap of L-203 which provides maximum gain and circuit stability. The tank circuit is resonated at 135MHz(mc) by C-208, C-209 and L-203. The addition of inductance by L-204 resonates the tank circuit at the lower frequencies; L-204 is ganged to the unit frequency selector control. The relatively high value of R-205 reduces the collector voltage of Q-201, thereby reducing the amount of noise generated in the rf amplifier.

Additional selectivity is provided by the circuit comprised of L-205, L-206, C-213, and C-214. This circuit operation is similar to the previous tuned circuit described above, with L-206 ganged to the unit frequency selector control. In sum, three tuned rf circuits are provided with tracking controlled by the communications unit selector control.

4-5. High Frequency Oscillator (Q-210), Frequency Doubler (Q-211).

The high frequency oscillator (Q-210) is a crystal stabilized, modified Colpitts oscillator operating in the range of 68.7375MHz (mc) to 77.2375MHz (mc) in 0.5MHz (mc) steps. A rotary selector switch deck, ganged to the unit frequency selector shaft permits selecting any one of the 19 crystals (crystal frequencies are given in Table 4-1) Capacitors C-251 and C-252 provide feedback to the selected crystal. The feedback capacitors plus C-253 and C-254 resonate with L-212 at 77.2375, the highest oscillator frequency. Tracking of the oscillator tank circuit over the lower frequencies is achieved with L-213, which is ganged to the unit

High Frequency			Low Frequency		
Desired Freq MHz(mc)	HFO Freq MHz(mc)	2HFO Freq MHz(mc)	Desired Freq kHz(kc)	Trans. HFIF & LFO(MHz)	RCVR LFO (MHz)
117	68.2375	136.475	00	19.475	18.975
118	68.7375	137.475	05	19.425	18.925
119	69.2375	138.475	10	19.375	18.875
120	69.7375	139.475	15	19.325	18.825
121	70.2375	140.475	20	19.275	18.775
122	70.7375	141.475	25	19.225	18.725
123	71.2375	142.475	30	19.175	18.675
124	71.7375	143.475	35	19.125	18.625
125	72.2375	144.475	40	19.075	18.575
126	72.7375	145.475	45	19.025	18.525
127	73.2375	146.475	50	18.975	19.475
128	73.7375	147.475	55	18.925	19.425
129	74.2375	148.475	60	18.875	19.375
130	74.7375	149.475	65	18.825	19.325
131	75.2375	150.475	70	18.775	19.275
132	75.7375	151.475	75	18.725	19.225
133	76.2375	152.475	80	18.675	19.175
134	76.7375	153.475	85	18.625	19.125
135	77.2375	154.475	90	18.575	19.075
			95	18.525	19.025

LFIF = 500 kHz(kc)

Table 4-1. COMMUNICATIONS TRANSCEIVER OPERATING FREQUENCIES

frequency selector control.

The oscillator frequency is doubled in Q-211 with undesired harmonics rejected by the band-pass filter (L-214, L-215, C-246, and C-257): series trap L-217 and C-271 attenuates the fundamental oscillator frequency. Transistor Q-211 is thermally stabilized by diode CR-207.

4-6. First Mixer (Q-202) and HFIF.

The rf amplifier is inductively coupled into the base of the first mixer (Q-202) through L-205. In addition, the high frequency oscillator injection is connected to the base through C-224 and R-253: R-253 is selected to optimize the injection level for that particular receiver. The AGC is connected to the base circuit of Q-202 through a decoupling network (R-207, C-215); however, this connection is through the cold side of L-205 secondary.

Although heterodyning of the two signals produces sum and difference frequencies. The tuning of the high frequency intermediate frequency (HFIF) transformers (T-201 and T-202) permits selection of the difference frequency.

The HFIF, which includes the collector tank circuit of Q-202, and the input network of Q-203, has two inter-stage transformers (T-201 and T-202). The primary

and secondary of each transformer is tuned through the 18.525 and 19.475 range by four separate variable inductors ganged to the shaft of the fractional unit selector switch. The four tuned circuits provide adjacent channel rejection.

4-7. Low Frequency Oscillator (Q-213).

The Low Frequency Oscillator (LFO) provides the local oscillator signal to the second mixer. The LFO is comprised of an untuned crystal controlled modified Colpitts oscillator (Q-213) controlled by a 20 position crystal selector switch (S-202). The crystal selector switch (COM fractional unit control) connects any one of 20 crystals into the oscillator, covering the range of 18.525MHz (mc) to 19.475MHz(mc) in 50kHz (kc) steps. Capacitors C-264 and C-265 provide the feedback necessary to sustain oscillation. The oscillator output is obtained directly from the emitter; L-221 attenuates harmonics in this line. Individual crystal frequencies are given in Table 4-1.

4-8. Second Mixer (Q-203) and LFIF Amplifiers (Q-204, Q-205).

The second mixer (Q-203), also referred to as second

converter, heterodynes the local oscillator (LFO) with the HFIF signal to provide the Low Frequency IF (LFIF) signal. Capacitors C-225, C-226, and C-227 tune the secondary of T-202 and provide impedance matching into the base of the mixer. The HFIF and LFO signals are connected to the base of Q-203, which derives dc bias from the voltage divider, R-210 and R-212. The two signals are heterodyned and the 500kHz (kc) difference frequency, which is selected by FL-201, is connected to Q-204. Bandpass filter FL-201 determines the LFIF response curve.

The 500 kHz (kc) LFIF signal is connected to LFIF amplifier Q-204, which is biased from the AGC buss. This stage is untuned with the signal AC coupled into the second LFIF amplifier, Q-205. Transistor Q-205 is fixed biased by voltage divider R-218 and R-251; the output signal is developed across the primary of T-203. Damping resistor R-225 is a select-by-test resistor which determines the transformer response curve.

4-9. Communication Detector (CR-203).

The COM detector demodulates the LFIF signal and provides operating signals for the preamplifier, AGC, and noise limiter circuits. The LFIF signal is obtained from the secondary of T-203 and detected by CR-203. Two signals are produced in the detection process: the first is the receiving of the voice or input information and the second is a dc level which varies in proportion to the carrier strength of the received signal. The DC component biases the noise limiter diode and the AGC amplifier while the ac component is applied to the noise limiter and thence to the audio preamplifier.

4-10 AGC Amplifier (Q-206).

The AGC amplifier provides a positive bias to the rf amplifier, first mixer, and LFIF amplifier that is a function of the carrier strength of the received signal. This positive bias applied to the above transistors serves to maintain a uniform level at the receiver output throughout a wide range of signal levels at the receiver input.

The detector output is connected through a low pass filter (R-221, R-222, C-242, C-243) to the base of Q-206, the AGC amplifier. Detector current flowing through the resistors establishes a bias at the base of Q-206 and a positive dc level is established due to conduction through R-223. The algebraic sum of detector output and dc bias determines the operating potential at the base of Q-206. The Q-206 collector is connected to +11 volts and the AGC output acts as the emitter load. Therefore, the Q-206 base potential determines the voltage at the AGC buss.

The AGC output, which is obtained from Q-206 emitter, provides forward bias to the rf amplifier, (Q-201), first mixer (Q-202) and the LFIF amplifier (Q-204). An increase in rf signal input to the receiver

is reflected in a decrease of positive bias connected to these NPN transistors and the overall gain is reduced.

4-11. Noise Limiter.

The noise limiter eliminates sharp noise bursts that exceed a predetermined level at the detector. Diode CR-204 is a series peak noise limiter. The voltage developed across the load resistors by detector current flow is applied to CR-204 through R-220 and R-224. This voltage normally forward biases the diode so that it passes the audio signal. A noise peak higher than the normal peak of voltage will reverse bias the diode, and the audio output will be cut off for the duration of the noise peak. Diodes CR-205 and CR-206 provide temperature compensation to stabilize the operation throughout a wide range of temperatures.

4-12. Audio Preamplifier (Q-208, Q-209).

The noise limiter output is coupled to the base of Q-208 and the collector direct coupled to the base of emitter follower, Q-209. The emitter follower load resistor is the volume control.

4-13. Squelch Gate (Q-207).

The Squelch Gate determines the threshold of squelch action in Q-208, the preamplifier stage. The squelch gate collector is connected to the direct coupling between Q-208 and Q-209. Since the emitter of Q-207 is connected to ground, saturation of this transistor effectively short circuits the input of the emitter follower to ground. The gate operates in either a cut off or saturated condition. When the output from the AGC amplifier exceeds the pre-determined level set by the front panel squelch control, Q-207 saturates and there is no output from Q-209. Shunting resistor R-204 is selected to set the maximum signal level at which squelch gate conduction will occur (about 30 microvolt level).

4-14. Audio Amplifier Modulator.

The three stage audio amplifier is used in the receiver as a voice amplifier, and in the transmitter as a modulator. The transmit/receive relay performs the switching operation. The mixed audio input (pin 22 of P-501) is coupled to the base of the first audio stage Q-404). The Q-404 output is direct coupled to Q-403, the audio driver stage. The Q-403 collector load is the primary of T-402, the push-pull input transformer. The push-pull output stage (Q-401, Q-402) derives the required operating signals from the secondary of T-402.

The audio amplifier (Q-401 thru Q-404) operates as a complete unit with the input and output connections switched when the Mike Key is activated and Pin 42 of P-501 is grounded. The circuit connections of K-501 for transmit and receive are given in Table 4-2.

Relay Poles	K-501 Coil Not Activated (Receive)	K-501 Coil Activated (Transmit)
K-501-A	A+ connected to Q-213 (Receive LFO)	A+ connected to Q-212 (Transmit LFO)
K-501-B	COM Antenna connected to receiver input	COM Antenna connected to transmitter output
K-501-C	Audio Amplifier input connected to Mixed audio input (J-501,22)	Audio amplifier input connected to Mike Audio input (J-501,17)
K-501-D	Open Circuit	+15 Volt transmitter power turned on
K-501-E	Open Circuit	T-401 +15V modulated to transmitter
K-501-F	T-401 speaker winding ground return connected	Sidetone winding divider network connected to ground

TABLE 4-2. TRANSMIT/RECEIVE RELAY CONNECTION

4-15. COMMUNICATIONS TRANSMITTER

4-16. Introduction.

The Mark-24 Communications Transmitter has 360 crystal controlled output frequencies spaced at 50kHz (kc) intervals within the 118 to 135.95MHz (mc) range. The export model has 380 frequencies within the 117 to 135.95MHz (mc) range. Frequency generation is accomplished by using two crystal controlled oscillators, a low frequency oscillator (LFO) and a high frequency oscillator (HFO) in a frequency synthesizer configuration. Two rotary selectors transfer the crystals and tuned circuits to mix the low frequency signal with the second harmonic of the high frequency oscillator and select the difference frequency (i.e. $F = 2 \text{ HFO} - \text{LFO}$).

4-17. High Frequency Oscillator (HFO, Q-210 and Q-211).

The HFO (Q-210) is a crystal stabilized modified Colpitts oscillator. The 2HFO signal which is derived from the output of the frequency doubler (Q-211) is also used as the oscillator signal source for the communications receiver. A bandpass filter (FL-301), covering the range of 136-154MHz (mc), is inserted in series with the HFO output line. This filter attenuates the fundamental frequency and has low feed thru attenuation to the second harmonic of the crystal oscillator. Refer to Paragraph 4-5 for the oscillator circuit description and Table 4-1 for the operating frequencies.

4-18. Low Frequency Oscillator (LFO, Q-212).

The LFO (Q-212) is an untuned crystal controlled Colpitts oscillator, operating within the 18.525 to 19.475 MHz (mc) range. The LFO is switched in

50kHz (kc) increments by a switch deck of S-202 that is ganged to the fractional channel selector switch on the communications receiver. A low pass filter is inserted in series with the LFO output line to reduce the high frequency components of the oscillator signal at the mixer. The operating frequencies are given in Table 4-1.

4-19. Balanced Mixer (Q-301, Q-302).

The LFO and HFO signals are combined in the balanced mixer, Q-301 and Q-302. The LFO signal is capacitively coupled into the primary of rf transformer L-302. The secondary provides LFO signal to the base circuits of Q-301 and Q-302. The HFO signal is injected at the midpoint of capacitive divider C-304, C-305 to provide the same amplitude 2HFO signal at the base of Q-301 and Q-302. The balanced mixer circuit rejects LFO because of the selectivity of the total output tank circuit and rejects 2HFO by means of the balanced configuration. The difference frequency between 2HFO and LFO is selected due to the sharply tuned characteristics of the output tank circuit. This circuit is tuned by variable inductor L-301, which is ganged to the shaft of the front panel units selector switch.

4-20. First RF Amplifier (Q-303).

The rf energy from the balanced mixer (2HFO -LFO) is coupled through C-308 to the base of the first rf amplifier (Q-303). The first rf amplifier is a Class A CW amplifier which obtains forward bias from the junction of R-305 and R-306. The output circuit is tuned by L-305, C-314, and the variable inductor (L-304) which is ganged to the shaft of the front panel units selector switch.

4-21. Second RF Amplifier (Q-304).

Capacitor C-313 couples the first rf amplifier output

into the base of Q-304. This transistor operates as a Class A CW amplifier, which obtains forward bias from the junction of R-311 and R-312. The emitter of Q-304 is connected to ground through thermal switch S-301, which is located in the heat sink of the final rf amplifier. The rf drive circuit will therefore be disabled if the final amplifier temperature rises above approximately 125°C. The output circuit is tuned by L-308, L-309, C-320, C-321 and C-322.

As shown in the schematic, L-301, L-304, and L-308 are variable inductors that are in the output circuits of the balanced modulator, first rf, and second rf circuits respectively. The total inductance in each tank circuit is determined by a fixed tuned inductor (L-306, L-305, and L-309), and a variable step inductor (L-301, L-304, and L-308). The variable inductors are ganged to the units selector switch. Therefore, when the crystal is selected, the three stages are resonated at this new frequency by inserting additional inductance in series with the fixed inductors.

4-22. Third RF Amplifier (Q-305).

The third rf amplifier input is obtained from a capacitive voltage divider (C-321, C-322) in the collector tank circuit of Q-304. This rf amplifier is a Class A modulated amplifier which obtains forward bias from the junction of R-315 and R-316. The Q-305 input circuit differs from the previous two stages since the bias divider is powered from the +15 volt modulated source. The first three rf stages are biased to operate as Class A amplifiers for maximum power gain and low heat dissipation. The collector circuit is tuned by L-312, and C-340: C-328 and C-330 serve as a divider network to match the input impedance of the driver (Q-306).

4-23. RF Driver and Final Amplifier (Q-306, Q-307).

The driver and final output stages are operated as Class AB linear amplifiers. The Q-306 and Q-307 emitters are returned to ground through one ohm resistors. This test point is used to monitor the emitter current since a VTVM will indicate 1.0 millivolt for each milliampere current flow in the circuit. The collector tank circuits of Q-305, Q-306, and Q-307 are broadband tuned to cover the operating range of the transmitter. The collector of Q-306 is tuned by L-315 and C-342. The Q-306 output is taken from a tap on L-315. The tapped section of L-315, together with C-339 and C-341 matches the input impedance of the final rf power amplifier (Q-307).

The output tank circuit of Q-307 is tuned by L-318, C-349, and the output low-pass filter (L-319 thru L-321 and C-350 thru C-353). The low-pass filter is a Tchebyscheff filter used in the output circuit to suppress any harmonics of the carrier frequency from being radiated by the antenna. The output coil (L-318) is connected as an auto transformer to match the low collector impedance to the 50 ohm antenna impedance. The transmitter output is a nominal 6 watts connected

to the antenna through K-501, the Transmit/Receive relay.

4-24. Modulator (Audio Amplifier).

Modulation is accomplished by transformer action in T-401 since the dc current in the modulated power amplifiers flows through one of the T-401 secondary windings. The +15 volt operating power is applied directly to the first two rf amplifiers (Q-303 and Q-304); however, power for the remaining rf amplifiers (Q-305 thru Q-307) is obtained from another source. The other source is the modulation winding of T-401 which is in series with this line: the +15 volts that powers the final rf amplifier section is modulated by the output of the audio amplifier. The operation of the audio amplifier and the transmit/receive operation is described in Paragraph 4-14.

A limiter circuit is included in the modulator to provide a higher peak modulation capability with a minimum of driving power. The limiter circuit is connected across the modulation transformer secondary (T-401) to eliminate the complete negative swing of the modulation signal applied to Q-304 only. The limiter circuit is comprised of diodes CR-301 and CR-302 (connected back-to-back), series resistor R-314, and shunting resistor R-318. The modulator supplies approximately 27 volts peak-to-peak to the driver and power amplifier.

4-25. Power Converter.

The +15 volts that operates the transmitter is obtained from a DC/DC power converter. The power converter is a low impedance source of power which isolates this unit from interaction with any other electrical equipment located on the aircraft. When operated from a 14 volt source, the power converter is a step-up device; from a 28 volt source it is a step-down device.

The DC input voltage is changed to AC (DC to AC conversion) and a transformer permits voltage step-up or step-down with the load circuit isolated from the aircraft power source. The required level of AC is rectified and filtered for the final DC output (AC to DC conversion).

The power supply operates as an electronic switch with two transistors (Q-503, Q-504) alternately conducting through the primary winding of T-501. When power is applied to relay K-501, current will flow through the emitter/collector circuit of Q-503 and Q-504. However, due to the inevitable dissimilarity of the two transistors, more current will flow in one of the transistors. The base circuits of the two transistors are connected to a feedback winding on the transformer to obtain bias. The feedback voltage due to the unequal flow of primary current induces a bias on the transistors such that the conducting unit is driven into greater conduction and the other is held at cut-off. The conducting transistor almost instantly drives the transformer core to saturation.

Having reached maximum flux density, there is no more induced voltage in the base circuit windings. Therefore, the current through the conducting transistor decreases

and bias voltage of the opposite polarity is developed which cuts off this transistor and simultaneously causes the second transistor to conduct. The above procedure repeats with the second transistor. The switching action is repeated at high speed and the resultant voltage at the output winding of T-501 is essentially a 6500Hz (cps) square wave.

A full wave bridge rectifier (CR-503, CR-504, CR-505, CR-506) is connected to the center tapped secondary of T-501 to provide a DC voltage output. The problem of filtering the DC voltage is simplified due to the relatively high operating frequency of the power supply.

4-26. NAVIGATION RECEIVER.

4-27. Introduction.

The Navigation Receiver has 100 crystal controlled channels spaced at 100kHz (Kc) intervals within the 108 to 117.9MHz (mc) range. The two crystal controlled oscillators with rotary selectors transferring the crystals and tuned circuits to: (1) mix the high frequency oscillator (HFO) injection with the received signal to obtain the first intermediate frequency (HFIF), and (2) mix the low frequency oscillator (LFO) injection with the HFIF to obtain the second intermediate frequency (LFIF). The LFIF output signal is detected and applied to a noise limiter, AGC circuit, and a buffer amplifier for the VOR-LOC information. A switchable IDENT filter is provided to attenuate the 1020Hz (cps) VOR/LOC station identification code.

4-28. R.F. Amplifier (Q-101).

The rf input signal to Q-101 is derived from the horizontally polarized antenna and connected to the tuned rf input circuit through pin 25 of J-501. Capacitors C-101 and C-102 serve as the antenna impedance matching network and C-104 and C-105 provide impedance matching into the base of Q-101. The total equivalent capacitance of C-103 and the four matching capacitors resonates with L-101 at 117MHz (mc). The additional inductance of L-102 permits tracking the tank circuit throughout the lower frequencies of 108 to 117MHz (mc). AGC is applied to the base of Q-101 through CR-105 and de-coupling network R-102 and C-106. Diode CR-105, which is connected to the AGC line, serves to reduce the gain of Q-101 during an increase of input signal, thereby preventing overloading of the following stages under moderate to high rf signal input levels.

The rf amplifier load circuit is comprised of the tank circuit of C-108, C-109, L-103, and L-104. As in the input circuit, the output circuit of C-108, C-109 and L-103 resonate at 117MHz (mc) with L-104 tracking the tank circuit tuning through the lower frequencies. Resistor R-105 reduces the collector voltage of the rf amplifier, thereby decreasing the amount of noise generated in this stage.

Additional selectivity is provided by the tank circuit

consisting of C-113, C-114, L-105, and L-106 operating as the previously described tuned circuits. The three tuned rf stages are tracked by the NAV unit selector switch (MHz) which is ganged to L-102, L-104 and L-106.

4-29. High Frequency Oscillator (Q-110).

The high frequency oscillator (HFO) is a crystal stabilized modified Colpitts circuit, operating within the range of 97.49 to 101.49MHz (mc) in 1MHz (mc) steps. Five crystals are located in the S-102 selector switch circuit. To sustain oscillation, feedback through the selected crystal is applied to the capacitive divider comprised of C-151 and the total equivalent capacitance of C-152, C-153, and C-161. This series of capacitors also serves as a divider with a tap to provide output power from the tank circuit. The total equivalent capacitance of the entire divider including C-151 plus C-154 resonates with L-111 at 101.49MHz (mc), the highest oscillator frequency. Variable inductor L-112, which is ganged to the NAV UNIT (MHz) selector switch, provides oscillator tank circuit tracking for the four remaining HFO frequencies.

It should be noted that only five crystals are provided in the HFO to cover ten MHz (mc) channels. Refer to the first mixer and HFIF circuit description (Paragraph 4-30) for the method of utilizing the crystals. Individual crystal frequencies are listed in Table 4-3.

4-30. First Mixer (Q-102) and HFIF.

The rf amplifier output is inductively coupled into the first mixer (Q-102) through L-105. High Frequency oscillator injection is applied through C-116 and R-112. The value of R-112 is adjusted at the factory to optimize oscillator injection for each particular unit. AGC bias is applied to the base of Q-102 through decoupling network R-107 and C-115.

The rf input signal and HFO injection are mixed in Q-102 and the difference frequency selected by the tuned collector tank circuit, the first HFIF stage. Although 10 full UNIT (MHz) channels from 108 through 117 are utilized, only five crystals are used in the HFO. This is accomplished by switching the HFIF either above or below the LFO injection frequency by an amount equal to the LFIF. The operating frequencies are given in Table 4-3 and a mathematical example is given in Table 4-5 to illustrate the receiver frequency conversion. To summarize from Table 4-3, the following operating frequencies are used:

- a. Each of the five HFO crystals is used twice in the conversion of the rf signal input to the HFIF.
- b. When the NAV channel selector is set between 108 and 112.9MHz (mc), the HFIF operates within the 10.51 to 11.41MHz (mc) range.
- c. When the NAV channel selector is set between 113.0 and 117.9MHz (mc), the HFIF operates within the 15.51 and 16.41MHz (mc) range.

HIGH FREQUENCY OSCILLATOR		LOW FREQUENCY OSCILLATOR		HFIF FREQUENCY	
Desired Freq MHz(mc)	HFO Freq MHz(mc)	Desired Freq MHz(mc)	LFO Freq MHz(mc)	HFIF 108-112 MHz(mc)	HFIF 113-117 MHz(mc)
108	97.49	.0	13.01	10.51	15.51
109	98.49	.1	13.11	10.61	15.61
110	99.49	.2	13.21	10.71	15.71
111	100.49	.3	13.31	10.81	15.81
112	101.49	.4	13.41	10.91	15.91
113	97.49	.5	13.51	11.01	16.01
114	98.49	.6	13.61	11.11	16.11
115	99.49	.7	13.71	11.21	16.21
116	100.49	.8	13.81	11.31	16.31
117	101.49	.9	13.91	11.41	16.41

LFIF = 2.5MHz(mc)

TABLE 4-3. NAVIGATION RECEIVER, OPERATING FREQUENCIES

- d. Throughout both of the above bands, the HFIF and LFO are always separated by 2.5MHz (mc) to obtain this LFIF signal.

As shown in the schematic diagram (Figure 7-1), with the NAV channel selector set within the 113.0 to 117.9 MHz (mc) range, the switch connected to the HFIF tank circuits (S-101A, S-101B) is in the open position. Under these conditions the Q-102 collector tank circuit consists of C-121, C-122, and the primary of T-101. The circuit resonates at 16.41MHz (mc) the highest frequency of the upper HFIF band. Variable inductor L-107, which is ganged to the fractional unit selector switch, permits tracking throughout the 15.51 to 16.41 MHz (mc) range.

When the NAV channel selector is set within the 108.0 to 112.9MHz (mc) range, S-101 is closed and the LFIF is switched to the lower band, 10.51 to 11.41 MHz (mc).

The additional capacitance of C-119 and C-120 connected across a portion of the tank circuit primary resonates this circuit within the low band range, 10.51 to 11.41MHz (mc). Capacitors C-123 and C-124 are connected to the T-101 secondary and perform as described above. The switch, which is ganged to the channel selector whole unit control, remains closed throughout the low range of the NAV receiver. Variable inductors L-107 and L-108 serve to track the tank circuit throughout the lower frequencies of the HFIF upper and lower bands. L-107 and L-108 are ganged to the shaft of the NAV fractional unit selector switch.

4-31. Low Frequency Oscillator (Q-111).

The low frequency oscillator (LFO) is an untuned crystal controlled modified Colpitts oscillator operating

within the 13.01 and 13.91MHz (mc) range in 0.10 MHz (mc) steps. A rotary selector switch (S-103) ganged to the fractional units channel selector switch connects one of the 10 crystals to the LFO circuit. Feedback to sustain divider C-157 and C-158. The output is taken directly from the emitter of Q-111.

4-32. Second Mixer (Q-103) and LFIF (Q-104, Q-105).

The HFIF and LFO circuits are connected to the input of Q-103, the second mixer; the 2.5MHz (mc) difference frequency (LFIF) is obtained from the output of Q-103. Capacitive divider C-127 and C-128 provides HFIF signal and impedance matching at the base of Q-103. LFO injection is through R-126 and C-129 to the base of Q-103. AGC bias is provided by R-113, which is connected from the AGC buss to the base of Q-103. The LFIF bandpass filter (FL-101), which is tuned to the center frequency of 2.5MHz (mc), selects the difference frequency between the two mixer inputs, the HFIF and LFO signals.

The FL-101 output is connected to the base of the first LFIF amplifier, Q-104. This stage has a resistive load in the collector circuit and AGC bias applied to the base. The LFIF signal is RC coupled into the base of the second LFIF amplifier. The base is connected to a fixed forward bias through R-218 and R-251. The collector load is the primary of T-102, the LFIF transformer. The LFIF bandpass characteristics are established by the response of FL-101; LFIF transformer T-102 is rather broadly tuned.

4-33. NAV Detector (CR-101).

The NAV LFIF signal is transformer coupled to the secondary of T-102, which is connected to the diode

	Frequencies in MHz (mc)	
	Low Band	High Band
Desired Frequency	112.00	117.00
HFO Injection Frequency	101.49	101.49
HFIF	10.51	15.51
LFO Injection Frequency	13.01	13.01
LFIF	2.50	2.50

TABLE 4-4. NAV RECEIVER FREQUENCY CONVERSION

NAV detector (CR-101). The detected output appears as two signals, the first is a DC voltage that is directly proportional to the rf carrier signal strength, and the second an AC signal representing the desired intelligence. Transistor Q-109 is a buffer amplifier to a navigation converter such as a VOA-8 or VOA-9.

4-34. AGC Amplifier (Q-106).

Both audio and dc are provided at the output of detector CR-101. The DC component is used in conjunction with the AGC amplifier (Q-106) to provide automatic gain control in the receiver. AGC voltage is supplied to Q-101, Q-102, Q-103, and Q-104.

The ac component of the detector output is applied to the noise limiter circuitry (diode noise limiter CR-102), then to Q-107, and Q-108 the audio preamplifiers.

The operation of the AGC and noise limiter circuits are similar to the description given in Paragraphs 4-10 and 4-11 of the communications receiver section.

The detector output is also applied to the base circuit of emitter follower Q-109, which serves as a buffer amplifier between the detector and VOR/LOC converter.

4-35. Noise Limiter.

The operation of the noise limiter circuit is similar to the operation of the COM receiver noise limiter. Refer to Paragraph 4-11 for the circuit description.

4-36. Navigation Output Preamplifier (Q-107, Q-108).

The noise limiter output is connected to the preamplifier transistors (Q-107, Q-108). The two transistors are direct coupled and the output taken from the volume control, the load resistor for emitter follower Q-108. The output circuit includes an audio trap tuned to 1020Hz (cps). The front panel IDENT switch activates the filter when VOR-LOC station identification is not desired.

4-37. IDENT Filter.

The IDENT filter is comprised of a parallel resonant circuit tuned to reject 1020Hz (cps). The parallel resonant circuit of C-146 and L-109 are tuned to 1020 Hz (cps). R-134 determines the circuit Q and the amount of 1020Hz (cps) rejection. The front panel switch (S-108) serves to disable the IDENT rejection circuit. With this switch circuit closed, this audio signal from Q-108 by-passes the filter. An open switch circuit provides rejection of the 1020Hz (cps) VOR-LOC identification code with voice communication signals retaining their intelligibility.

4-38. Voltage Regulator (Q-501).

The +11 volt regulator circuit is comprised of a series regulator that is controlled by a Zener diode. The combination of series resistor (R-501) and Zener diode (CR-501) is connected from +14 volts to ground. This provides a regulated bias of +11 volts at the base of Q-501 and therefore approximately 10.5 volts regulated is available at the emitter of Q-501.

The +11 volt line is protected by Q-502 with diode CR-507 reverse biased to prevent Q-502 from conducting. In the event of a short on the regulated line or excessive current drain, CR-507 is forward biased and Q-502 will saturate. This action places the base of Q-501 at ground potential and the series regulator ceases to conduct. This prevents excessive current flow through Q-501 and consequent damage to the transistor.

SECTION 5 MAINTENANCE

5-1. INTRODUCTION.

This section provides information necessary for the periodic maintenance, checkout, troubleshooting, and repair of the Mark-24. Complete instructions are given for alignment, adjustment, and tuning of the communication transceiver and navigation receiver.

5-2. MECHANICAL MAINTENANCE

5-3. Periodic Maintenance.

The Mark-24 requires no regularly scheduled maintenance of any mechanical parts. All moving parts have been lubricated and adjusted at the factory and will require no additional maintenance on a periodic basis.

5-4. Replacement of Mechanical Parts.

The front panel assembly includes: (1) the four direct drive shafts for rotating the channel selector switches; and (2) their associated bevel gear assemblies connected to the individual numbered wheels of the channel indicators. All bevel gears are constructed of brass and will require no maintenance; however, the four detent gears are constructed of a thermoplastic material (Delrin) that requires care in handling.

CAUTION

Do not allow any hot soldering iron to touch the detent gears.

The disassembly procedures, starting in the next paragraph (5-5), provides adequate instructions for removal of the various sub-assemblies when desiring access to any part of the MK-24.

5-5. Dis-assembly Procedures for Removal of Electrical Sub-Assemblies.

CAUTION

Turn OFF the primary power before starting to disassemble the Mark-24. Accidental grounding can damage the equipment.

The Mark-24 is comprised of the electronic sub-assemblies shown in Figures 5-1 and 5-2. This paragraph will describe the sequence of disassembly of the Mark-24 for removing any of the above assemblies for checkout or repair; then, for the re-assembly. In most cases, the reassembly will be the same as disassembly only in the reverse order. Where this procedure is

obvious it will not be repeated; however, when there is any difference between the two procedures, the re-assembly will be described in detail.

Some of the printed circuit boards can be removed without disturbing adjacent assemblies; however, others will require disassembly of the associated channel selector shafts (whole unit and/or fractional unit).

CAUTION

Do not move the front panel selector or rotate any of the switch wafers after removal of the selector shaft.

Removal of the oscillator assemblies (LFO and HFO) and rf assemblies of the NAV and COM sections will require removal of the associated channel selector shafts. In all cases, the front panel must be removed to permit extracting the shaft that rotates the channel selector switch. The procedures given below provide detailed instructions for removal of the front trim panel, extraction of the shaft and removal of the various assemblies for access to the individual components.

A. Front Trim Panel.

1. Set the COM controls to 135.00, the NAV controls to 108.0 and remove the channel selector knobs (4) and volume control knobs (2) by loosening the two set screws in each knob.
2. Remove the squelch knob by pulling away from trim panel. This knob is secured by a friction fit, no set screws.
3. Remove the IDENT actuator by prying the "E" ring retainer parallel to the front of the radio to remove from the groove (use small screwdriver), then remove the spring washer.
4. Remove the four screws from the side flanges of the trim panel. The panel may now be removed.

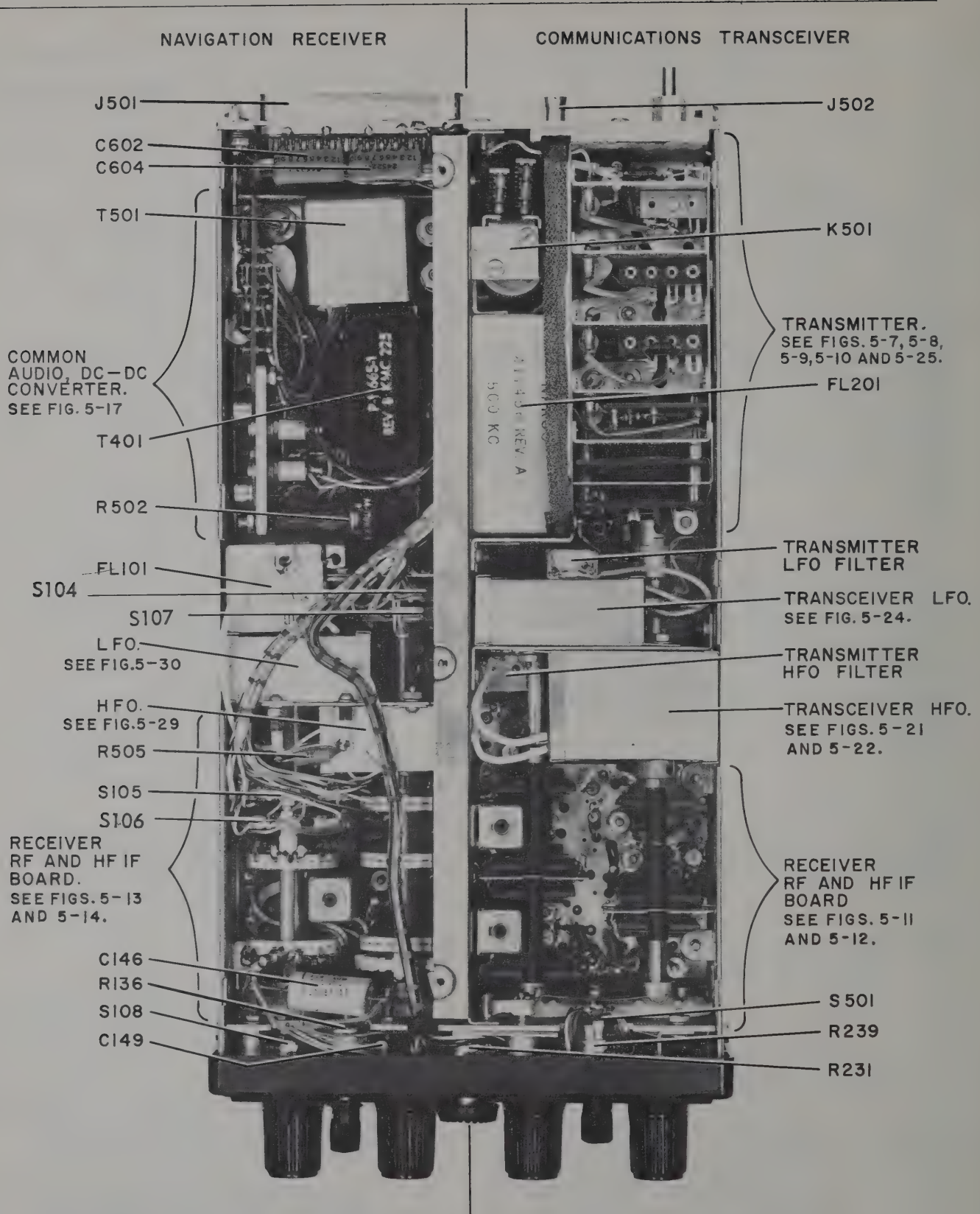
B. Removal of NAV Channel Selector Shafts.

1. Loosen the single set screw securing the collar to the shaft (adjacent to the detent gear). The protruding end of the shaft is shown in Figure 5-4.
2. If necessary, rotate the shaft to the extreme counterclockwise (CCW) position. Since the knobs have previously been removed, install the knobs temporarily for this operation.

NOTE

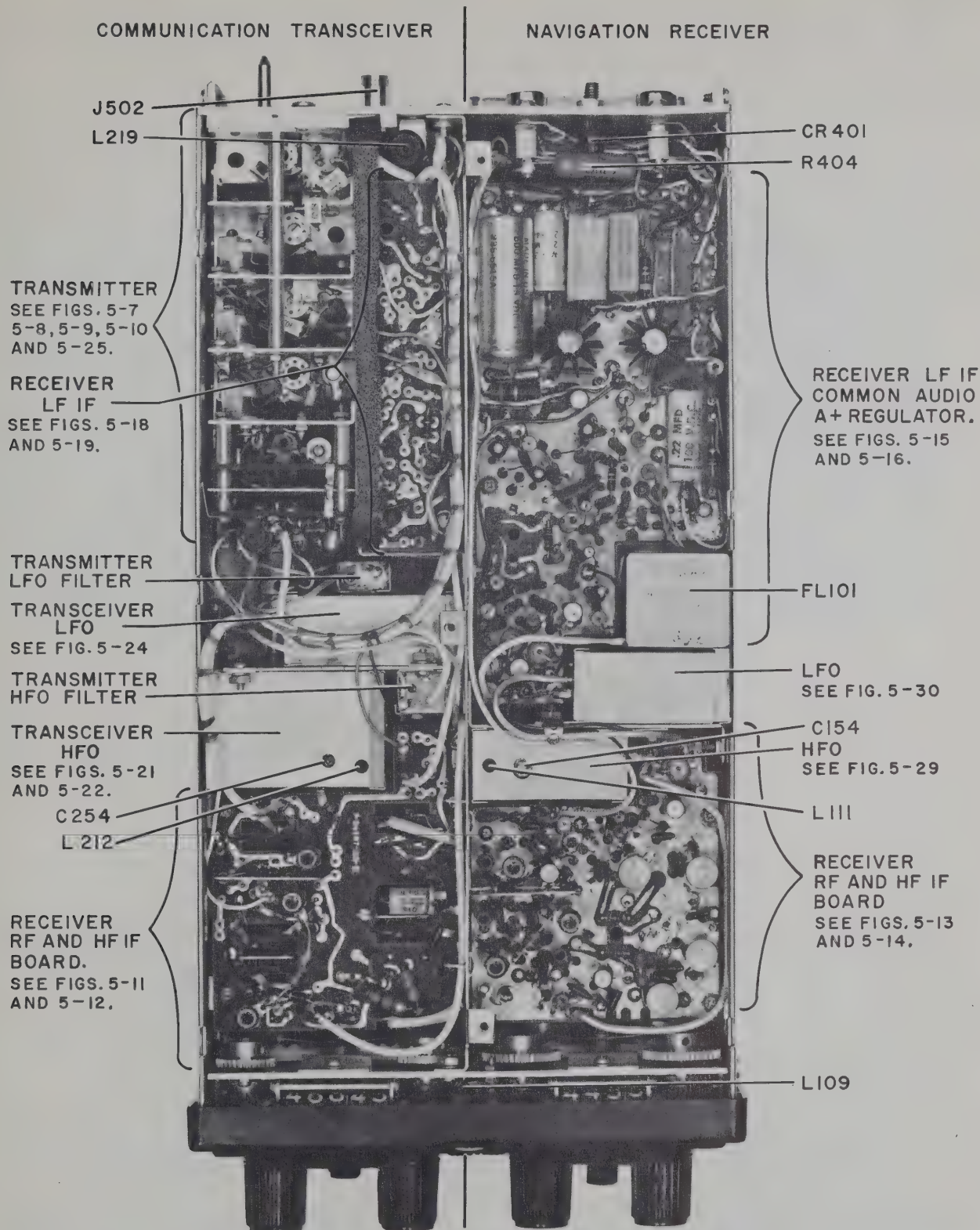
The channel indicator will read 108 or 0, the flats on the shaft will be vertical, and the pin through the shaft will be horizontal.

3. Pull the shaft from the front of the radio.



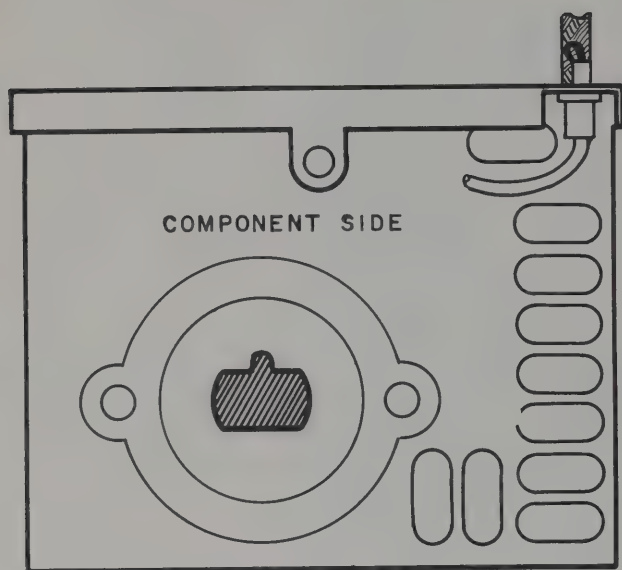
NAR-493

FIGURE 5-1. narco MARK-24, BOTTOM VIEW SHOWING LOCATION OF SUBASSEMBLIES

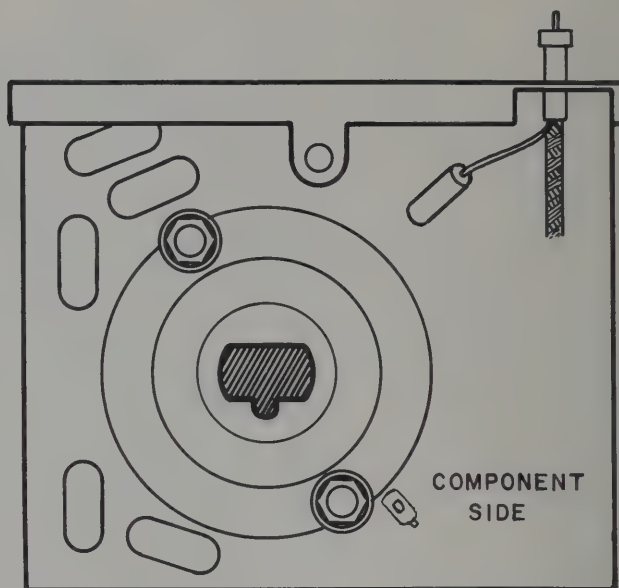


NAR-492

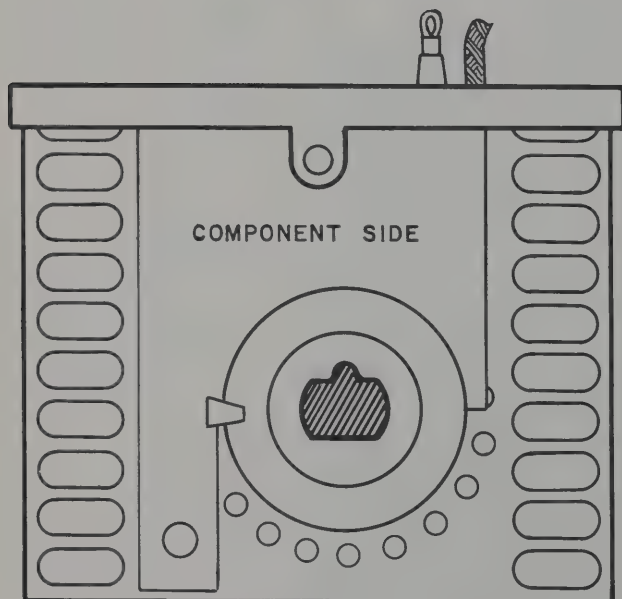
FIGURE 5-2. narco MARK-24, TOP VIEW SHOWING LOCATION OF SUBASSEMBLIES



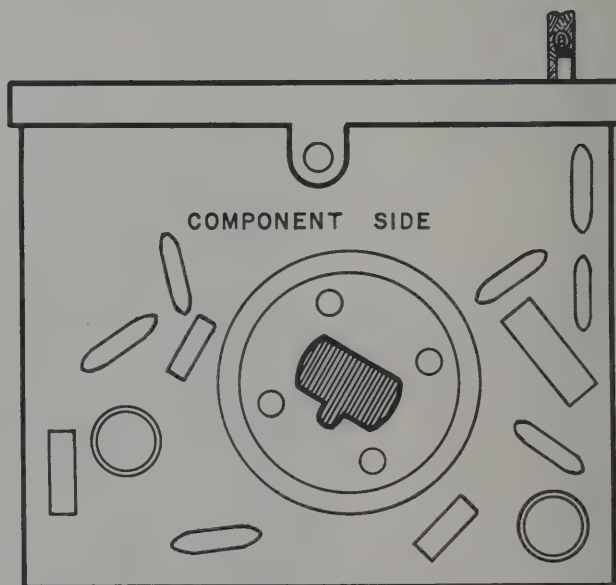
SHOWN IN .0MHz (13.01MHz) POSITION.
CW ROTATION FOR ASCENDING FREQUENCY.
NAV. L.F.O.



SHOWN IN 108MHz (97.49MHz) POSITION.
CCW ROTATION FOR ASCENDING FREQUENCY.
NAV. H.F.O.



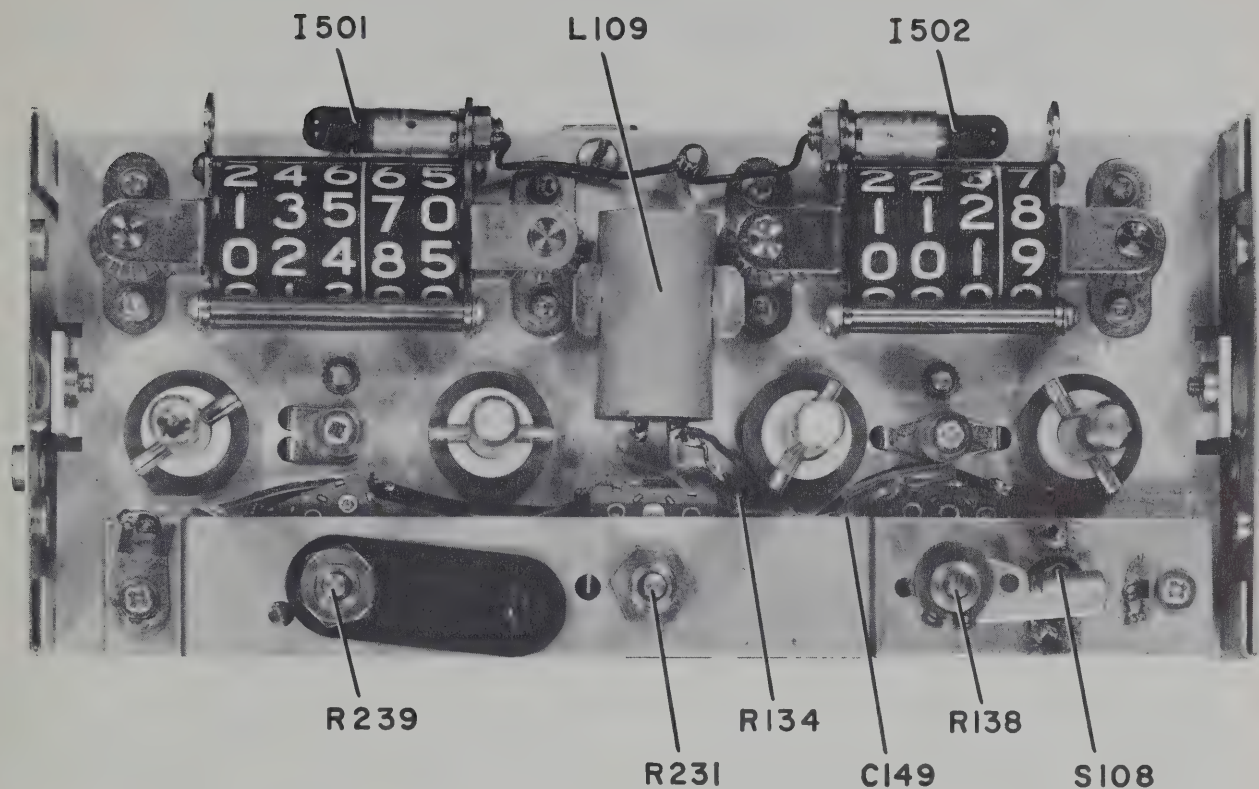
SHOWN IN .00mc RECEIVE (18.975MHz) POSITION.
CCW ROTATION FOR ASCENDING FREQUENCY.
COM. L.F.O.



SHOWN IN 118MHz (68.7375MHz) POSITION.
CW ROTATION FOR ASCENDING FREQUENCY.
COM. H.F.O.

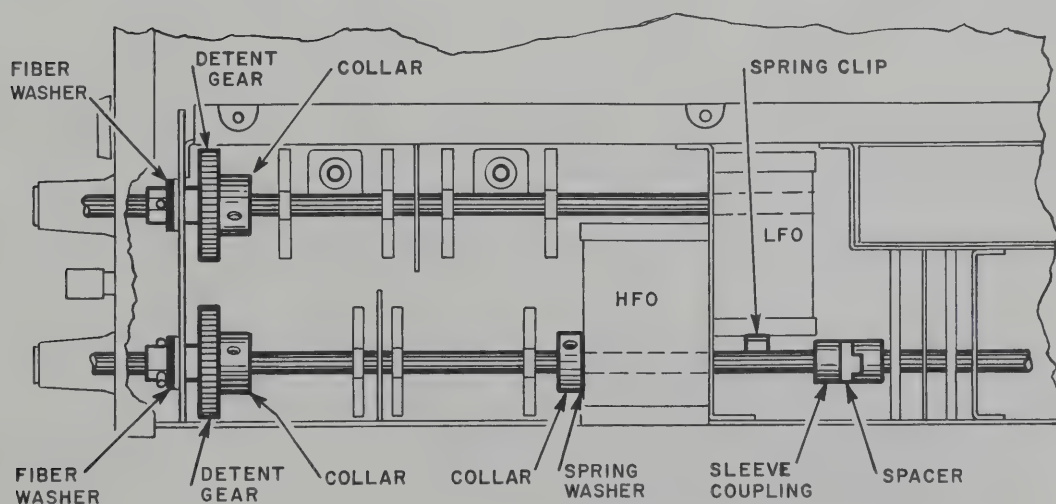
P-07196

FIGURE 5-3. OSCILLATOR SWITCH WAFER DETENT INDEXING



NAR-497

FIGURE 5-4. *narco* MARK-24, FRONT VIEW WITH PANEL REMOVED



M-07230

FIGURE 5-5. REMOVAL OF COM UNIT SELECTOR SWITCH SHAFT

CAUTION

It will be difficult to reassemble the switch if the shaft is rotated during removal.

4. Retrieve the collar (step 1) and remove the fibre washer remaining on the hub of the detent gear.

C. Removal of COM Fractional Unit (kHz) Channel Selector Shaft.

1. Rotate the shaft to the OO position on the channel indicator. Since the knob has previously been removed, install the knob temporarily for this operation.
2. Proceed as directed in steps 3 and 4 of the previous paragraph (5-5,B).

D. Removal of COM Full Unit (MHz) Channel Selector Shaft.

NOTES

- a. The side panel may be removed to facilitate servicing of adjacent assemblies as described in paragraph F.
 - b. Components are located and identified in Figure 5-5.
1. Loosen the single set screw in the collar against the detent gear.
 2. Loosen the single set screw in the collar adjacent to the HFO assembly. Refer to Figure 5-1 for the location of the HFO.
 3. Remove the spring wedged under the units shaft, between the LFO case and the shaft.
 4. Observe the position of the gap of the rotor ring on the mixer board of the transmitter as-

sembly as shown in Figure 5-7. The gap will be located 1/16 inches from the clip when the unit selector is set to 135MHz(mc); this same distance must be maintained when re-assembling. Loosen the set screws (2) in the front section of the flexible coupling.

NOTE

The angular position of the coupling on the selector shaft affects the alignment and tracking of the transmitter. After re-assembly, the transmitter must be realigned as described in Paragraphs 5-21, 5-22, and 5-23.

5. Pull the shaft from the front of the radio.

CAUTION

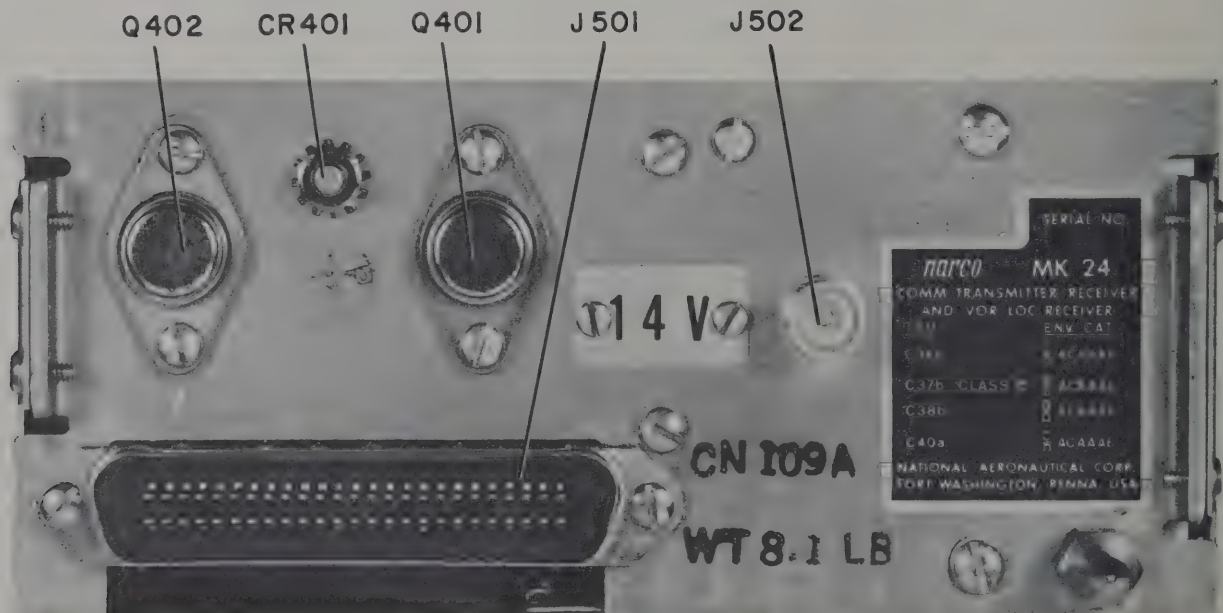
It will be difficult to reassemble the channel selector if the shaft is rotated during removal.

6. Retrieve the end piece and center section of the shaft coupling, collar and spring washer against the HFO case, the collar against the detent gear, "W" shaped spring, and the fibre washer on the hub of the detent gear. Store the above items in a safe place so that they will be available for reassembly.

E. Removal of Oscillator Cases.

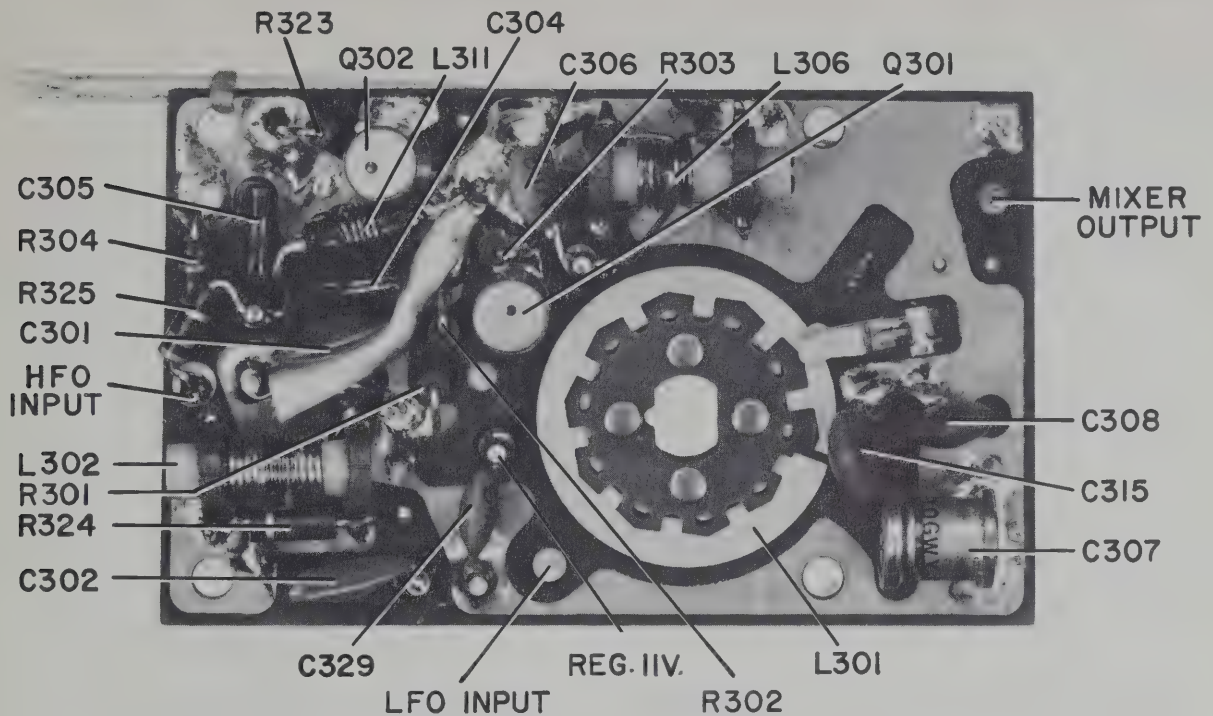
This procedure applies to the four crystal oscillator assemblies. For removal of shafts refer to the previous paragraphs.

1. Remove the trim panel as directed in paragraph A.



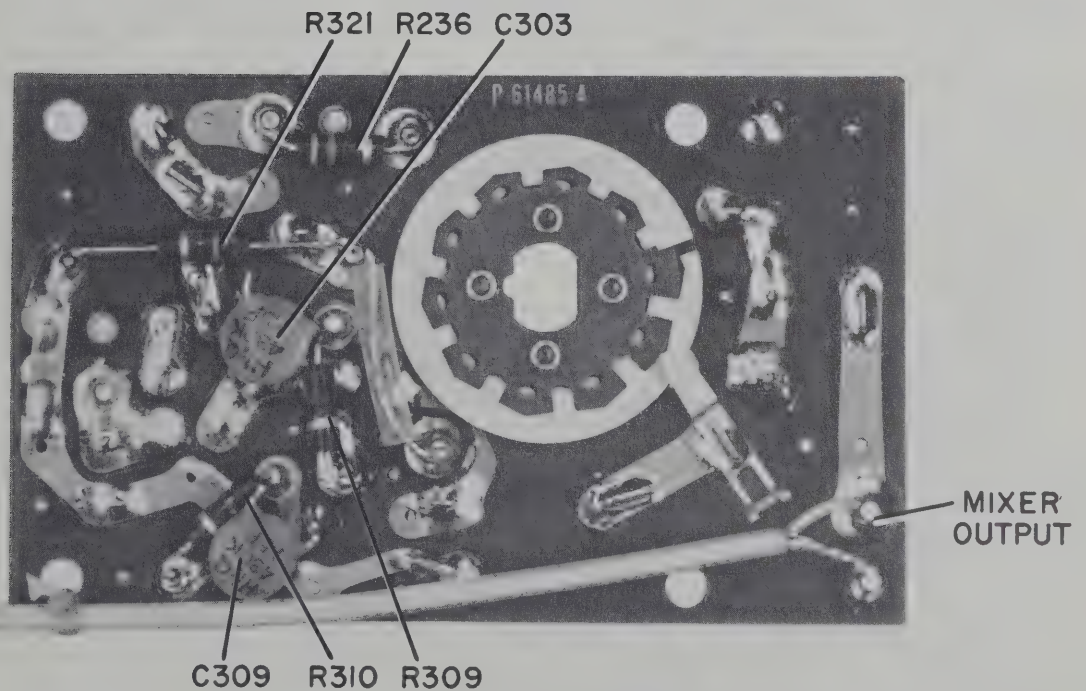
NAR-486

FIGURE 5-6. narco MARK-24, REAR PANEL VIEW



NAR-545

FIGURE 5-7. COM TRANSMITTER BALANCED MIXER, VIEWED FROM THE FRONT



NAR-544

FIGURE 5-8. COM TRANSMITTER BALANCED MIXER, VIEWED FROM THE REAR

2. Remove the channel selector shaft extending through the oscillator case.
3. Disconnect the A+ lead from the feedthru capacitor located on the side of the case and disconnect the coax cable.

CAUTIONS

- a. The A+ regulator will be damaged if the A+ lead is grounded while the power switch is ON.
- b. The coax cable will be damaged if the oscillator assembly is permitted to dangle or move around excessively.
4. Remove the single 4-40 screw securing the case to the support bracket and loosen the 4-40 nut located on the opposite side of the case.

NOTE

The screw is located at the top of the radio for the COM oscillators and the bottom of the radio for the NAV oscillators.

5. Remove the oscillator assembly from the radio.

NOTE

The NAV oscillators are removed from the top and the COM oscillators are removed from the bottom.

F. Removal of Side Panels.

1. Remove two screws securing the RF and HFIF printed circuit board to the two brackets located on the inner surface of each side panel.
2. Remove the single screw from the front of the side panel. Figure 5-4 shows the location of this screw.

NOTE

This screw is partially covered by the side flange of the trim panel; however, it may be removed by loosening the two screws securing that particular side of the front panel, one or more of the knobs, and moving the trim panel forward for access to the screw.

3. Remove the two screws from the rear of the side panel. Figure 5-6 shows the location of the two screws.
4. Remove the two remaining screws from the COM side panel. Four remaining screws must be removed from the NAV side panel. Total number of screws: NAV side panel has 7 screws removed from outside and 2 from inside; COM side panel has 5 screws removed from outside and 2 from inside.

G. Removal of COM Transmitter Assembly.

1. Remove side panel as described above.
2. Disconnect the LFO and HFO cables connected to the balanced mixer board. Refer to Figures 5-7 and 5-8 for coax input points.
3. Disconnect the wire (white-blue tracer) connected to the tie point located on the transmitter mounting bracket and remove the wire (white/orange tracer) connected to the LFO

feed thru capacitor (C-260). Refer to Figure 5-7 for location of this point.

4. Disconnect the wire (white/red tracer) connected to C-347, adjacent to relay K-501. Refer to Figures 5-9 and 5-10 for location of components.
5. Rotate the selector shaft until the slot in either coupling sleeve is in a horizontal position.
6. Remove the two screws securing the front of the transmitter assembly to the center panel.
7. Remove the two screws securing the rear of the transmitter assembly to the rear panel. Screws are located above and below the rear panel label.
8. Withdraw the transmitter assembly from the radio: disconnect the output coax from the relay if required.

H. Removal of COM Receiver RF and HFIF Board.

1. Remove the trim panel, channel selector shafts, and side panel as described in Paragraphs A, C, D, and F.
2. Remove the ground springs located between the tops of the IF cans and the center panel.
3. Disconnect the four coax cables (antenna input, HFO input, LFO input, and LFIF filter), the regulated +11 volt line (orange) and the AGC line (white). Refer to Figures 5-11 and 5-12 for location of these connections.
4. Disconnect the soldered ground strap to the center panel and the soldered connection to the HFO case.
5. Withdraw the board from the radio.

I. Removal of NAV RF and HFIF Board.

1. Remove the trim panel, channel selector shafts, and side panel as described in paragraphs A, B, and F.
2. Disconnect the three coax cables (antenna input, LFO input, and HFO input), AGC line (white), and regulated +11 volt line (purple) from the top of the board. (Refer to Figures 5-13 and 5-14 for location of components).
3. Disconnect the coax cable (LFIF) from the bottom of the board.
4. Unsolder the shield secured to the tab on the center panel.
5. Withdraw the board from the radio.

J. Access to Power Supply and NAV LFIF/AUDIO Section.

1. Servicing NAV LFIF and AF Board near side panel
 - a. Remove the side panel as described in paragraph F.
 - b. From the top of the printed circuit board, remove the four screws that pass through the board into threaded spacers in the

power supply sub-chassis.

- c. Tilt the board upward for soldering to either side of the component board.

CAUTION

Excessive pressure on the board will possibly damage the feed-thru capacitor located on the LFO oscillator case or damage the LFIF circuit board.

2. Servicing NAV LFIF and AF Printed Circuit Board Near Center Panel.
 - a. Remove the trim panel, NAV Kc selector, shaft and LFO assembly as described in paragraphs A, B, and E.
 - b. Remove the 4-40 screw and nut, located above the NAV LFIF board that secures the transmitter to the center panel.
 - c. From the top of the printed circuit board, remove the four screws that pass through the board into threaded holes in the chassis.
 - d. Lift the board. Refer to Figures 5-15 and 5-16 for location of components.

CAUTION

Excessive pressure on the board will damage leads attached to the underside of the board.

3. Servicing DC-DC Converter Board.
 - a. Remove the side panel as described in paragraph F.
 - b. Remove the two screws that extend through the chassis flange, spacers, and secure to threads in the heat sink.

K. Removal of COM LFIF Printed Circuit Board.

- a. Remove the two screws securing the board to the brackets on the center panel.
- b. Carefully lift the edge of the board adjacent to the center panel and remove from radio to the extent that the cabling permits.

CAUTION

The lead connected to the printed circuit board components will be damaged if the printed circuit board is forced beyond the slack in the wiring.

5-6. Re-assembly of Electrical Sub Assemblies.

The re-assembly is essentially the reverse of the disassembly. To reassemble the Mark-24 after disassembly, refer to the applicable disassembly procedure (paragraph 5-5A thru K) and perform the steps in the inverted order.

5-7. ELECTRICAL MAINTENANCE.

This paragraph provides electrical maintenance procedures to be used for operational checks, trouble isolation checks, and alignment of the Mark-24. The operational checks of the COM transceiver and NAV receiver indicate when there is a malfunction and the area in which it is located. Having identified the area

of malfunction, the trouble isolation checks further localize the trouble to the proper area. At this time the voltage and signal measurements will indicate that a weak or "no signal" condition is the result of component failure or improper alignment of the RF, IF or audio circuits. If a circuit requires alignment and alignment is performed, the radio will be able to pass all the tests given in the overall operating check (paragraphs 5-9, 5-10, and 5-11).

The schematic, component board photographs and parts list are cross referenced to facilitate rapid location of components and test points. The Mark-24 schematic has test voltages and test point references printed in red. The test points are identified on the photographs included in this section.

Each electrical component is identified on the photograph by the symbol reference given in the schematic. In addition, the component is listed in the order of symbol numbers in the parts list given in Section 6. The parts list provides sufficient information for ordering replacement parts or ordering special parts by number from *narco*.

5-8. List of Recommended Test Equipment.

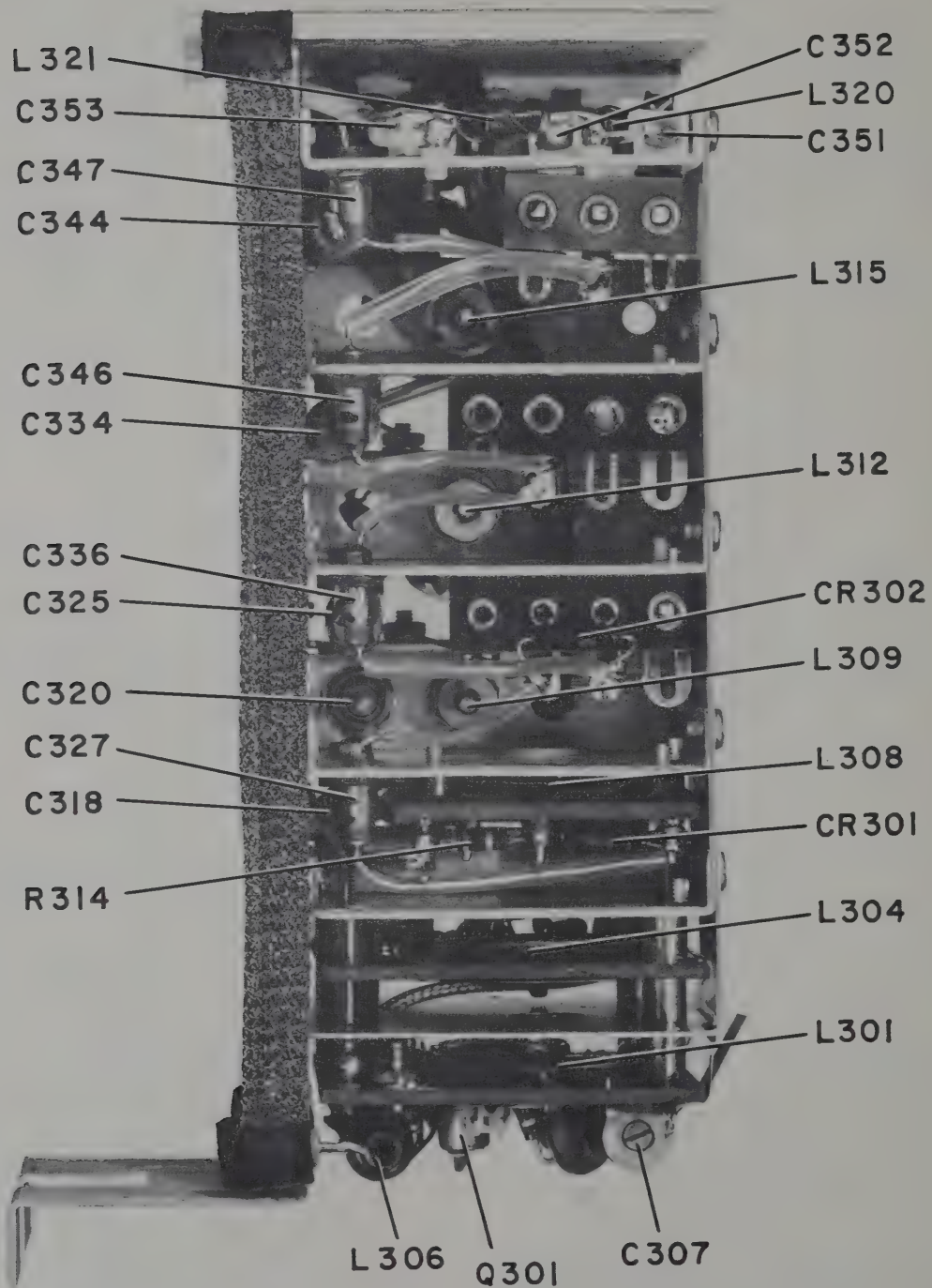
The list of test equipment for the overall operating checks, trouble isolation checks, and RF/IF alignment is given in Table 5-1. Interconnection diagrams are given as required for the specific alignment procedure.

5-9. Overall Operating Checks, COM Transmitter.

- A. RF Power Output Check. Connect the rf power meter to J-502 as shown in Figure 5-20A and key the "Press-to-talk" button on the microphone. The output power shall be 6.0 watts nominal (4.0 watts minimum).
- B. Microphone input voltage at start of clipping. Connects as shown in Figure 5-20, A and B and adjust the audio oscillator output until the oscilloscope indicates just below clipping. The signal level, as indicated by the AC VTVM at pin 17, the mike input shall be within the range of 0.1 volts rms (minimum) to 0.3 volts rms (maximum).
- C. % Modulation at Start of Clipping. Connect as shown in Figure 5-20 A and B and perform the test as directed below. Increase the audio signal until the oscilloscope indicates clipping. The percentage modulation at this point shall be 90% nominal (85% minimum).

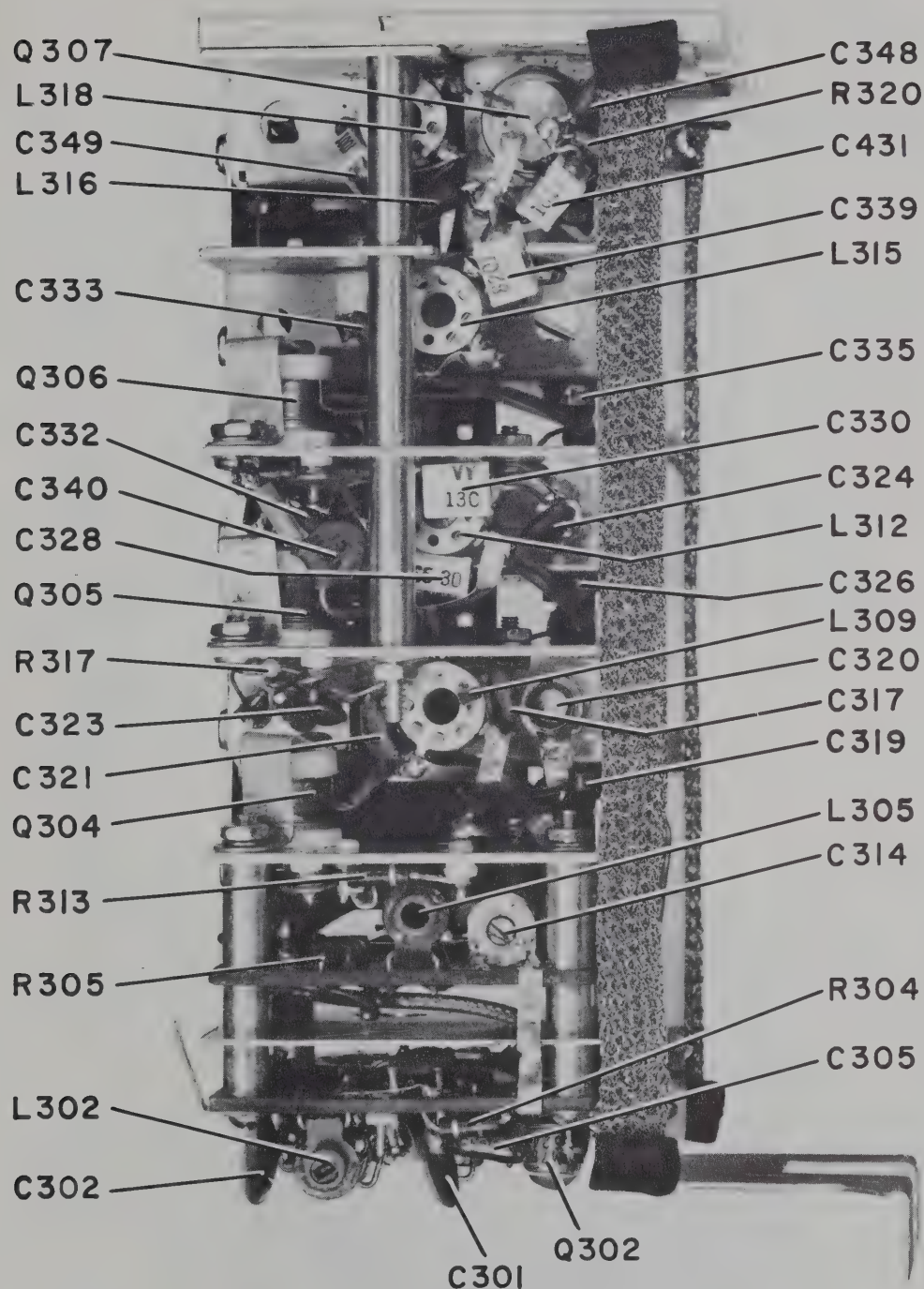
PERFORM THE % MODULATION TEST AS FOLLOWS:

1. Connect the transmitter as shown in Figure 5-20.
2. Set the oscilloscope vertical input for DC operation and .2V/Division, internal sync.



NAR-503

FIGURE 5-9. COM TRANSMITTER ASSEMBLY, BOTTOM VIEW

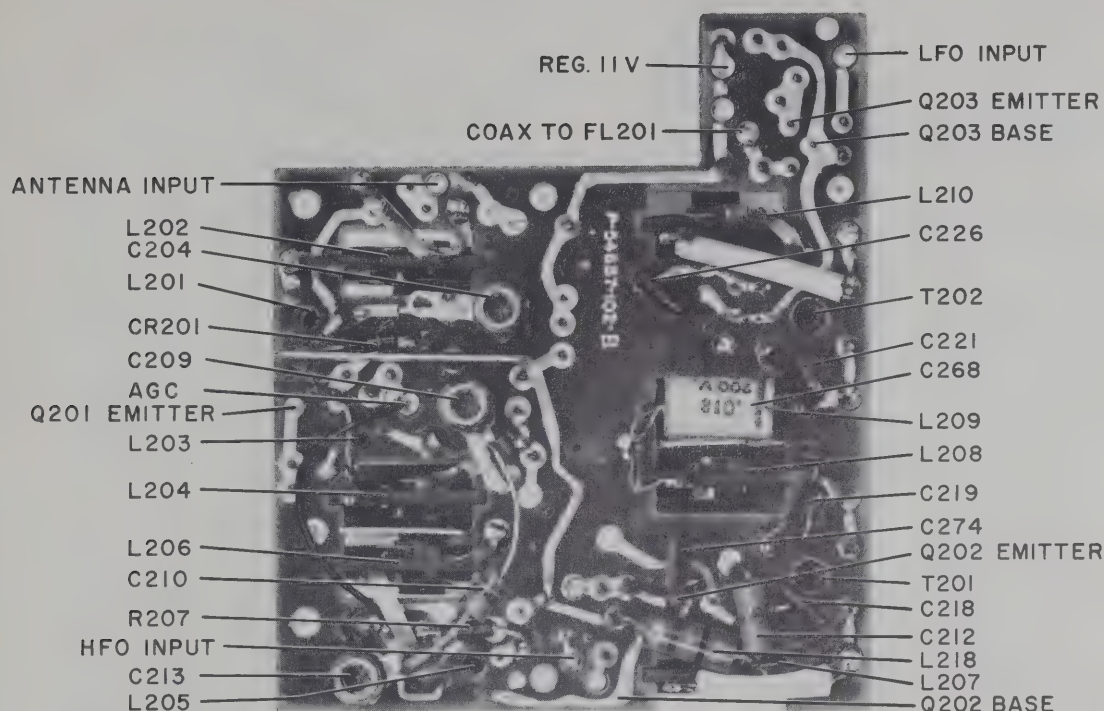


NAR-502

FIGURE 5-10. COM TRANSMITTER ASSEMBLY, TOP VIEW

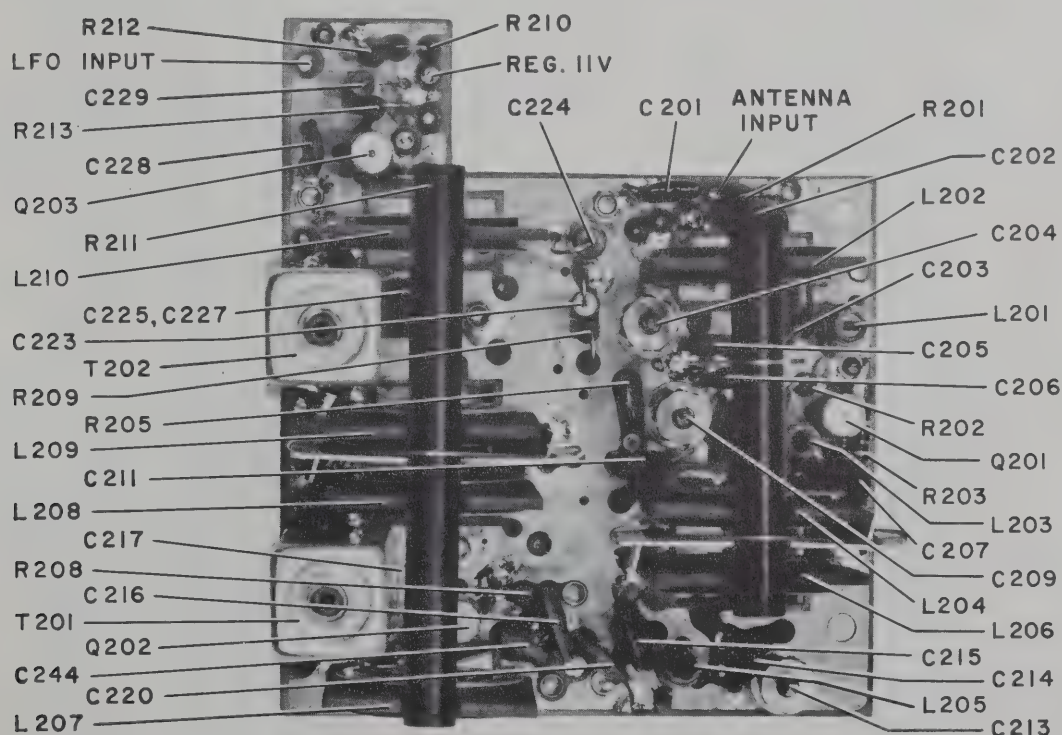
Test Equipment	Desired Characteristics	Model No.
VHF Signal Generator		General Radio Type 1001-A
VHF Signal Generator		Hewlett Packard 608 or equivalent
Low Voltage Reg DC Power Supply	0 to 36 volts at 0 to 5 amps	Power Design Model 3650-S or equivalent
DC Coupled Oscilloscope	450kHz(mc) Vert. Amp. 10 MV/CM Sensitivity	Tektronix 504 or equivalent
OMNI Signal Generator		Aircraft Radio Corp. Model H-14 or equivalent
Audio Wattmeter		General Radio Model 583A or equivalent
RF Power Wattmeter	10 Watt, 100 to 250MHz(mc)	Bird thruline Model 43 or equivalent
Low Power RF Milliwattmeter Microwave Power Meter		Hewlett Packard Model 430 C or equivalent
Thermistor Mount		Hewlett Packard Model 477B or equivalent
RF Power Attenuator	20 db, 20 watts, 50 ohms	Microlab AD-205N or equivalent
RF coaxial attenuator	20 db, 50 ohms 6 db, 50 ohms	General Radio 874-GB
		874-G20
RF Coaxial Detector		General Radio 874-VQ or equivalent
RF coaxial termination	50 ohms, watts	General Radio 874-W50B
AC VTVM		Ballantine Model 300 or equivalent
Audio Signal Generator		
DC VTVM and Crystal Diode Probe		RCA Senior Volt ohmyst Model 98C or equivalent
		WG-301A or equivalent

TABLE 5-1. LIST OF RECOMMENDED TEST EQUIPMENT



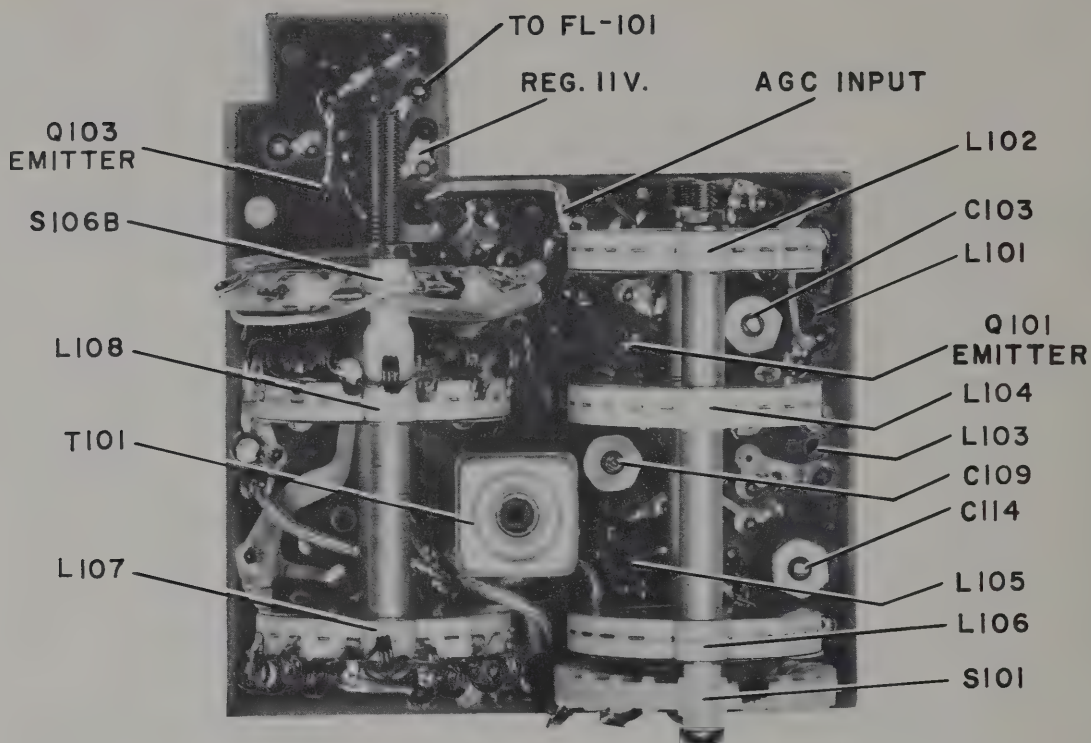
NAR-495

FIGURE 5-11. COM RECEIVER RF AND HFIF BOARD, TOP VIEW



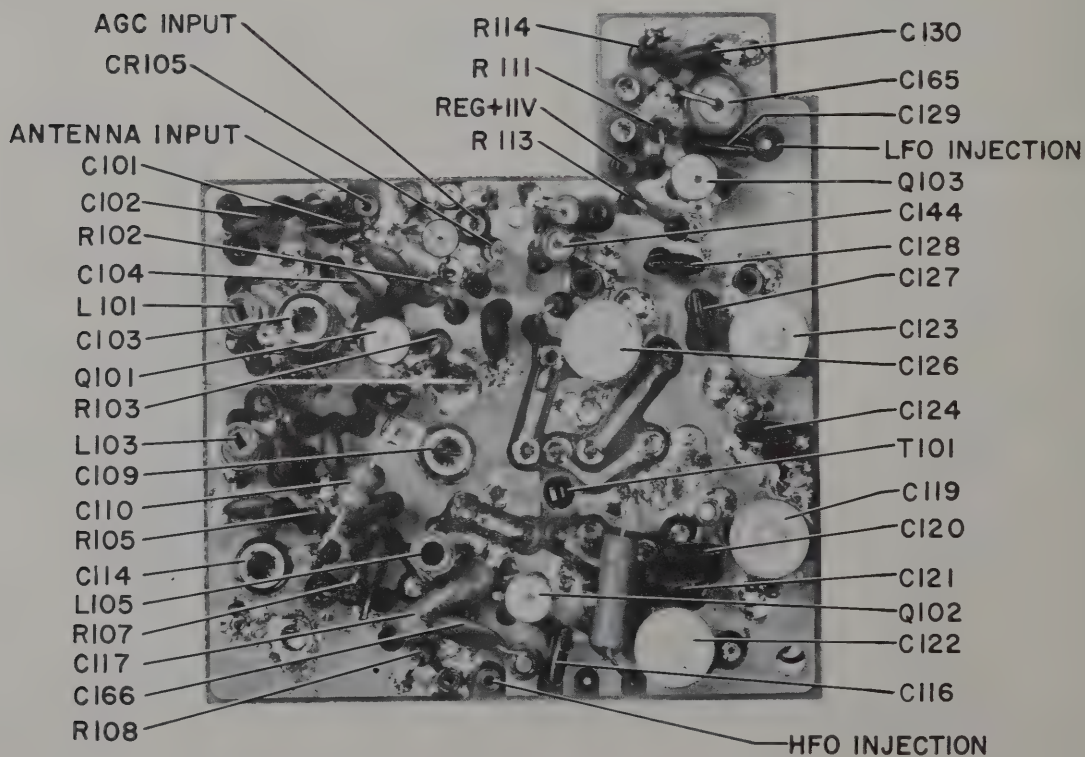
NAR-489

FIGURE 5-12. COM RECEIVER RF AND HFIF BOARD, BOTTOM VIEW



NAR-484

FIGURE 5-13. NAV RECEIVER RF AND HFIF BOARD, BOTTOM VIEW



NAR-504

FIGURE 5-14. NAV RECEIVER RF AND HFIF BOARD, TOP VIEW

3. Set the position of the oscilloscope trace two divisions below the horizontal center line on the graticule.
4. Key the transmitter modulation and adjust the oscilloscope vertical gain to position the unmodulated zero line two divisions above the horizontal center line on the graticule.

NOTE

When the transmitter is turned off, the trace must return to its initial position (two divisions below the horizontal center line on the graticule). When the transmitter is keyed once more, the trace will move a total of four divisions.

5. With the transmitter keyed, apply 1,000 Hz (cps) modulation and adjust the modulating signal level for maximum unclipped amplitude on the oscilloscope.

$$\% \text{ Mod.} = \frac{\text{Maximum unclipped sine wave amplitude as observed on scope}}{4 \text{ (no. of divisions unkeyed/keyed)}}$$

$$\text{Example: } \frac{3.6 \text{ Div}}{4 \text{ Div}} = .9 \times 100 = 90\%$$

- D. Operational Voltage Limit Checks. The transmitter shall operate when the A+ input is varied -20% and +10% of the nominal line voltage.

5-10. Overall Operating Checks, COM Receiver.

NOTE

In the tests given below, the COM signal into antenna connector J-502 shall be obtained from the rf signal generator modulated 30% by a 1 kHz (Kc) signal. The output shall be monitored by the audio wattmeter connected to pins 14 and 16 of J-501.

- A. Sensitivity Check. With a maximum signal of 1.5 μ volts at the input, the audio output shall exhibit a 6 db $\frac{S + N}{N}$
- B. Receiver Gain. With a maximum signal of 2.5 μ volts at the input the audio output shall be 5 watts.
- C. AGC Check. Vary the rf signal generator amplitude from 10 to 10,000 μ volts. The audio output shall not vary more than 5 db.
- D. RF Image Rejection Check.
 1. Tune the rf signal generator to the same frequency as the COM channel indicator.
 2. Adjust the signal generator output to produce 6 db $\frac{S + N}{N}$ and note the signal generator and audio output levels. Refer to Step A for $\frac{S + N}{N}$ procedure.

3. Increase the signal generator output 60 db and tune the signal generator to the image frequency (refer to specifications in Section 1 for image frequencies).

4. Adjust the signal generator output level to produce the above audio output reference level.

A minimum of 60 db increase of signal generator output over the reference output level shall be necessary to reproduce the audio output level.

- E. IF Image Rejection Check.

1. Tune the rf signal generator to the same frequency as the COM channel indicator.
2. Adjust the signal generator output to produce 6 db $\frac{S + N}{N}$ and note the signal generator and audio output levels. Refer to Step A for $\frac{S + N}{N}$ procedure.

A minimum of 60 db increase of signal generator output over the reference output level shall be necessary to reproduce the audio output level.

3. Increase the signal generator output 60 db and tune the signal generator to the image frequency (refer to specifications in Section 1 for image frequencies).

4. Adjust the signal generator output level to produce the above audio output reference level. A minimum of 60 db increase of signal generator output over the reference output level shall be necessary to reproduce the audio output level.

- F. Audio Frequency Response Check

1. Adjust the rf signal generator output for 1 millivolt.
2. Adjust the receiver volume control to produce 5 watts of audio output. When the rf signal generator modulation frequency is varied from 350Hz (cps) to 2500Hz (cps) the audio output shall not vary more than 6 db.

- G. Squelch Action Check.

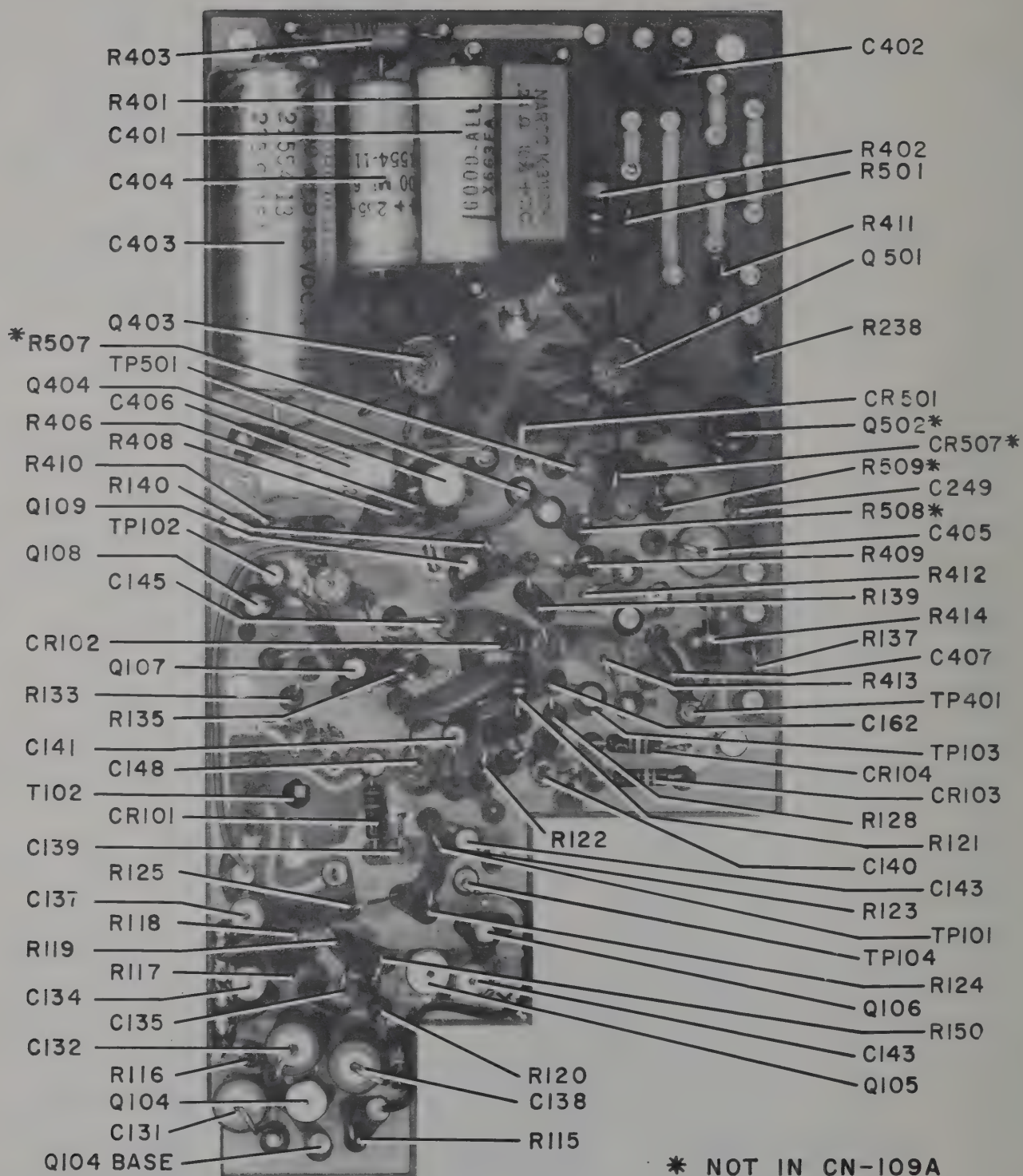
1. With a normal rf signal into the COM receiver, set the squelch control to the full CCW position.
2. Adjust the rf signal generator attenuator until the squelch opens. The maximum rf input to the receiver shall be 30 μ volts.

- H. Operational Voltage Limit Checks. The receiver shall operate when the A+ input is varied -20% and +10% of the nominal line voltage.

5-11. Overall Operational Checks, NAV Receiver.

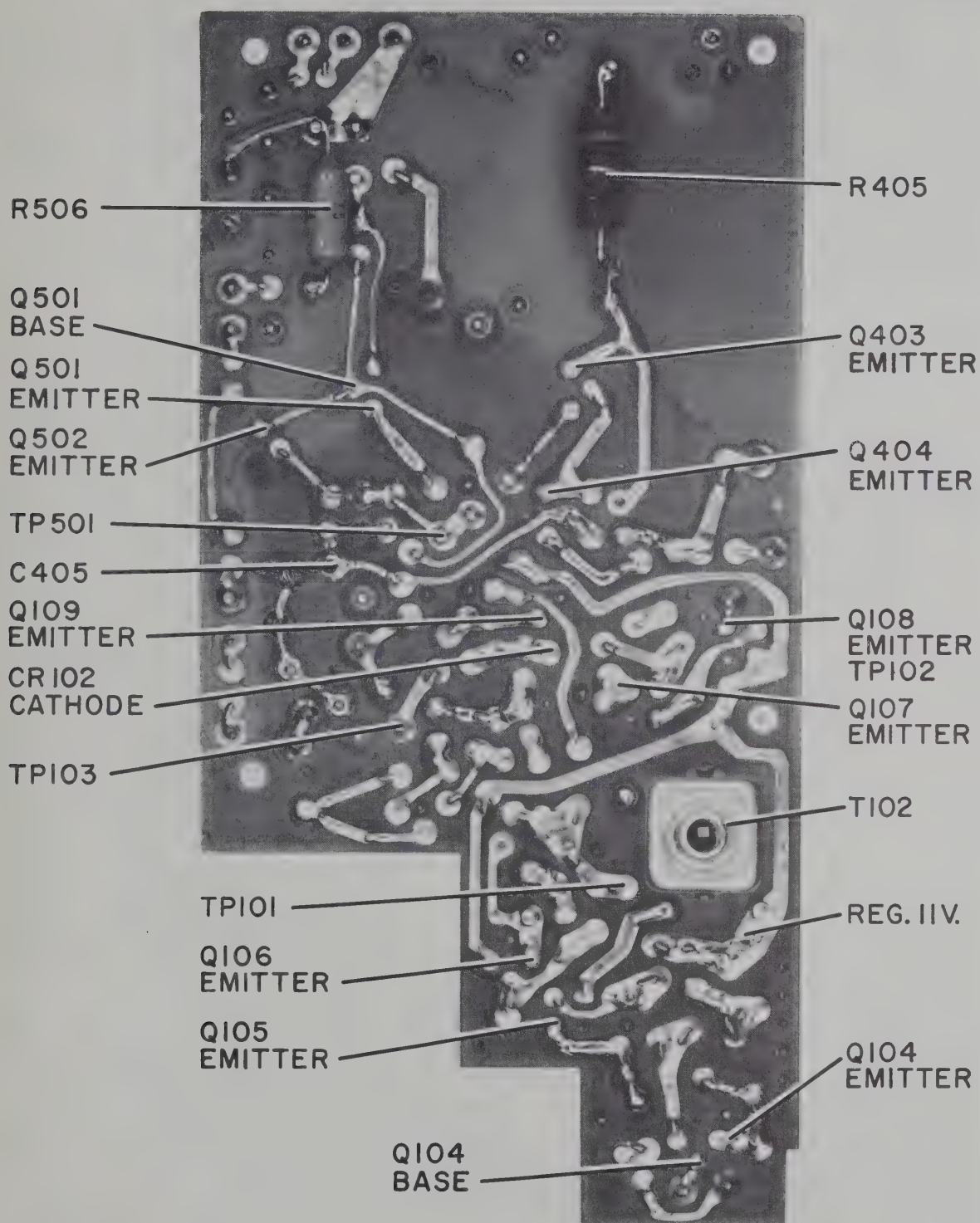
NOTE

In the tests given below, the NAV signal shall be obtained from the rf signal generator, modulated 30% by a 1kHz (kc) signal. The output shall be monitored by the audio wattmeter connected to pins 14 and 16 of J-501.



NAR-547

FIGURE 5-15. NAV RECEIVER AF AND LFIF BOARD, TOP VIEW



NAR-546

FIGURE 5-16 NAV RECEIVER AF AND LFIF BOARD, BOTTOM VIEW

A. Sensitivity Check. With a maximum signal of 1.5 μ volts at the input, the audio output shall exhibit a 6 db $S + \frac{N}{N}$

B. Receiver Gain. With a maximum signal of 2.0 μ volts at the input, the audio output shall be 5 watts.

C. AGC Check. Vary the rf signal generator output from 10 to 10,000 μ volts. The audio output shall not vary more than 4 db.

D. RF Image Rejection Check.

1. Tune the rf signal generator to the same frequency as the NAV channel indicator.
2. Adjust the signal generator output to produce 6 db $S + \frac{N}{N}$ and note the signal gen-

erator and audio output levels. Refer to Step A for $S + \frac{N}{N}$ procedure.

3. Increase the signal generator output 65 db and tune the signal generator to the image frequency (refer to specifications in Section 1 for image frequencies).
4. Adjust the signal generator output level to produce the above audio output reference level. A minimum of 65 db increase of signal generator output over the reference output level shall be necessary to reproduce the audio output level.

E. Tracking Error.

With 3 μ volts rf input modulated 30% by 1kHz(kc), the minimum value measured at pin 24 shall be 0.175 volts rms minimum.

F. IF Image Rejection Check.

1. Tune the rf signal generator to the same frequency as the NAV channel indicator.
2. Adjust the signal generator output to produce 6 db $S + \frac{N}{N}$ and note the signal gen-

erator and audio output levels. Refer to Step A for $S + \frac{N}{N}$ procedure.

3. Increase the signal generator output 65 db and tune the signal generator to the image frequency (refer to specifications in Section 1 for image frequencies).
4. Adjust the signal generator output level to produce the above audio output reference level. A minimum of 65 db increase of signal generator output over the reference output level shall be necessary to reproduce the audio output level.

G. Audio Frequency Response Check.

1. Adjust the rf signal generator output for 1 millivolt.
2. Adjust the receiver volume control to produce 5 watts of audio output. When the rf signal generator modulation frequency is varied from 350Hz (cps) to 2500Hz (cps)

the audio output shall not vary more than 6 db.

H. IDENT Filter Check.

1. Modulate the rf signal generator with 1020 Hz (cps) and set the IDENT switch to the ON position (UP). Adjust the volume control to produce 5 watts of audio.
2. Move the switch to the OFF (down) position. The difference in signal level as indicated at the wattmeter shall be 15 DB minimum.

I. Operational Voltage Limit Checks.

The receiver shall operate when the A+ input is varied -20% and +10% of the nominal line.

5-12. Trouble Isolation in the Mark-24.

The Mark-24 is comprised of the COM Transceiver and the NAV Receiver with various circuits common to both. In troubleshooting an inoperative Mark-24, the common interconnections can be used to isolate a malfunction to the responsible area. An example of the above is that the audio assembly is common to both sections since the COM receiver has it connected as a voice amplifier, the COM transmitter has connections as a modulator, and the NAV receiver has connections as an output amplifier. Therefore, if audio is not present during the operational checks and the transmitter has power output but is incapable of being modulated, it can be assumed that the audio amplifier-modulator is at fault. The above is of value when determining the general area in which the difficulties exist.

Once isolated to a section of the Mark-24, the specific fault may be further isolated by a logical sequence of stage by stage testing. The alignment procedure will serve as a guide in this description and provide the information relative to input-output matching, signal levels and required response of each stage in the receivers and transmitter. DC voltages and waveforms may be obtained from the schematic. In troubleshooting a receiver that operates below the specified performance levels, the basic operational checks in paragraphs 5-9, 5-10, and 5-11 are of value in locating the malfunctioning circuits.

The external channel control of a glide slope receiver is performed by S-104A and B, S-105A and B, and S-106A. The external channel control of DME such as *narco* UDI-2AR is performed by S-106B and S-107. The control functions are performed by grounding selected wires through additional decks of the channel selector switches of the NAV receiver. Tables 5-2 and 5-3 indicate the circuits to ground for all positions of the channel selector switches.

5-13. Trouble Isolation in the COM Transmitter.

CAUTION

Connect the transmitter rf output into a termi-

NAV Channel MHz(mc)	Glide Slope Channel MHz(mc)	CONNECTOR P/J 501 PIN NO.											
		1	26	2	27	4	29	5	30	6	31	7	32
108.0	—		X										
108.1	334.7	X	X	X									
108.2	—		X										
108.3	334.1	X	X		X								
108.4	—		X										
108.5	329.9	X	X			X							
108.6	—		X										
108.7	330.5	X	X				X						
108.8	—		X										
108.9	329.3	X	X					X					
109.0	—												
109.1	331.4	X							X				
109.2	—												
109.3	332.0	X								X			
109.4	—												
109.5	332.6	X									X		
109.6	—												
109.7	333.2	X										X	
109.8	—												
109.9	333.8	X											X
110.0	—												
110.1	334.4	X		X									
110.2	—												
110.3	335.0	X			X								
110.4	—												
110.5	329.6	X				X							
110.6	—												
110.7	332.0	X					X						
110.8	—												
110.9	330.8	X						X					
111.0	—		X										
111.1	331.7	X	X						X				
111.2	—		X										
111.3	332.3	X	X							X			
111.4	—		X										
111.5	332.9	X	X								X		
111.6	—		X										
111.7	333.5	X	X									X	
111.8	—		X										
111.9	331.1	X	X										X
112.	—			X*	SEE NOTE BELOW								
113.	—			X*									
114.	—			X*									
115.	—												
116.	—												
117.	—												
118.	—												

NOTES

1. X signifies that the circuit is at ground potential.
2. Since P/J 501-pins 1 and 26 control the OMNI/LOC and G/S circuits, they are not grounded when the channel selectors are set above 111.9MHz(mc). There is grounding of the remaining pins of P/J 501 listed above as the channel changes are made; however they can be disregarded since the activate leads are not grounded above 111.9MHz(mc).

TABLE 5-2. CHANNEL SELECTOR GROUND CIRCUITS, OMNI/LOC AND GLIDE SLOPE (S-104A AND B, S-105A AND B, AND S-106)

CONNECTOR P/J 501 PIN NO.

Frequency MHz(mc)	Fractional MHz(mc)					Units MHz(mc)				
	37	13	38	15	40	35	51	12	10	34
108.0		X			X					
108.1	X	X								
108.2	X		X							
108.3		X	X							
108.4		X		X						
108.5			X	X						
108.6			X		X					
108.7				X	X					
108.8	X			X						
108.9	X				X					
109.0							X			X
110.0							X		X	
111.0									X	X
112.0						X			X	X
113.0						X			X	
114.0								X	X	
115.0						X		X		
116.0						X	X			
117.0							X	X		
118.0								X		

NOTES

1. Fractional MHz(mc) sequence (S-106B 0.1 to 0.9) repeated for each MHz (mc) from 108 to 118MHz(mc).
2. X signifies that the circuit is at ground potential.

TABLE 5-3. CHANNEL SELECTOR GROUND CIRCUITS, DME (S-106B, S-107).

nated wattmeter or a dummy load so that no signal is radiated during tests.

The transmitter can be operated continuously for periods up to 10 minutes with no degradation of output signal. If operated for periods beyond this time limit, the temperature increase in the output stages will cause a decrease in the power delivered to the antenna. This degradation due to temperature increase can be minimized by using a blower for air circulation to assist in dissipating the heat.

When the malfunction has been traced to the transmitter the alignment procedure may be referred to for tests to determine the condition of individual stages. The schematic will provide DC voltage and necessary waveforms.

For rapid checks of low level rf signals, including the oscillator output, use the DC VTVM and rf probe. If either of the oscillators is inoperative (LFO or HFO), exciter signal can be simulated by using a signal generator as described below. Disconnect the mixer output from the base of Q-303 and connect an rf signal generator (tuned to the transmitter frequency) to this point through a 430 pf coupling capacitor. Set the signal generator to ODB = 1 mw and check the transmitter output.

CAUTION

Accidental shorting or grounding of the emitter resistors in the low level stages (mixer, 1st, 2nd, and 3rd rf amplifiers) will destroy the associated transistor.

If a low output or non-operative condition is found in the transmitter, use the alignment instructions for that particular stage as a final precise checkout. With the correct input and output matching, the performance of the stage can be checked with a high degree of accuracy. Following this, the next course would be alignment and/or voltage and resistance checks to locate the malfunctioning part.

5-14. Trouble Isolation in the COM Receiver.

Having isolated the malfunction to the COM receiver, the procedure given below will further localize the trouble to the malfunctioning stage. The alignment procedures given in paragraphs 5-27 to 5-33 provide sufficient information to tune each stage with the input and output circuits matched and the correct input level. The schematic diagram in Figure 7-3 provides the cir-

cuit connections and the service data of Figure 7-4 provides the key DC operating potentials under zero signal input conditions. Trouble isolation may be accomplished with DC voltage tests and stage-by-stage signal sensitivity checks.

Since the audio amplifier assembly is common to the COM and NAV receivers, the amplifier input may be combined with the outputs from the two receivers. Connect the following three P/J-501 connector pins together: mixed audio input (pin 22), NAV audio output (pin 23) and the COM audio output (pin 48). Connect the audio wattmeter to pins 14 and 16 to monitor the receiver output.

5-15. Trouble Isolation in the NAV Receiver.

Having isolated the malfunction to the NAV receiver, the procedure given below will further localize the trouble to the malfunctioning stage. The alignment procedures given in paragraphs 5-34 to 5-41 provide sufficient information to tune each stage with the input and output circuits matched and the correct input level. The schematic diagram in Figure 7-3 provides the circuit connections and the service data of Figure 7-4 provides the key DC operating potentials under zero signal input conditions. Trouble isolation may be accomplished with DC voltage tests and stage-by-stage signal sensitivity checks.

Since the audio amplifier assembly is common to the COM and NAV receivers, the amplifier input may be connected with the outputs from the two receivers. Connect the following three P/J-501 connector pins together: mixed audio input (pin 22), NAV audio output (pin 23) and the COM audio output (pin 48). Connect the audio wattmeter to pins 14 and 15 to monitor the receiver output.

5-16. ALIGNMENT PROCEDURE, COM TRANSMITTER

5-17. High Frequency Oscillator/ Doubler (Q-210, Q-211)

References: Schematic, Figure 7-1; Assembly Location, Figures 5-1 and 5-2; Parts Location, Figure 5-21 and 5-22; Switch wafer detent indexing, Figure 5-3; and Test Setup Figure 5-23A, B, and C.

NOTE

The oscillator must be in its shield box during all power and frequency measurements.

Procedure:

- Disconnect the center conductor of the HFO coax cable from the input of FL-301; then connect the rf milliwatt-meter to the center conductor and chassis ground, as shown in Figure 5-23 A.
- Note the milliwatt-meter indication when rotating the unit channel selector through all positions.

Normal Indication: 7 milliwatts minimum.

- If the above output is low, set the channel selector to 135MHz (mc) and adjust L-212 for maximum power.

- Set the channel selector to 118MHz (mc) and adjust C-254 for maximum power.
- Remove the rf wattmeter cable and re-connect the HFO output coax to the HFO filter (FL-301).

5-18. Transmitter HFO Filter, Feed-thru Attenuation Check.

- Disconnect the coax cable from the output of FL-301, the HFO filter and connect the rf milliwatt-meter input to this point.
- Measure the rf power at 118 and 135MHz(mc).

Normal Indication: Not less than half (3 db) the level measured in paragraph 5-7 (minimum 3.5 milliwatts).

5-19. Transmitter Low Frequency Oscillator (Q-212).

References: Schematic, Figure 7-1; Assembly Location, Figures 5-1 and 5-2; Parts Location, Figure 5-24; and switch wafer detent indexing, Figure 5-3.

NOTE

The oscillator must be in its shield box during all power and frequency measurements.

Procedure:

- Disconnect the LFO coax from the input to the LFO filter.
- Cut the leads of a .01μf disc capacitor to 1/8 inch and solder one end to the coax center conductor.
- Connect the rf milliwattmeter to the other end of the capacitor.
- Activate the Press-to-talk switch and rotate the fractional units selector control through all positions (.00 to .95MHz).

Normal Indication: 1.5 to 2.5 milliwatts.

- Remove the .01 μf capacitor and solder the LFO output cable to the filter terminal.

5-20. Transmitter LFO Filter Check.

References: Schematic, Figure 7-1; Parts Location Figure 5-1.

Procedure:

- Disconnect the coax cable from the LFO filter output.
- With a .01μf isolation capacitor in the test lead, connect the milliwatt meter to the LFO filter output terminal (refer to Paragraph 5-19 for connection of the .01μf capacitor).
- Activate the transmitter with the press-to-talk switch and rotate the fractional (kHz) channel selector through all channels.

Normal Indication: Power output shall be not less than 0.4 milliwatts on all kHz (kc) channels.

5-21. Balanced Mixer Alignment (Q-201, Q-302).

References: Schematic, Figure 7-1; Assembly Location, Figures 5-1 and 5-2; Parts Location, Figures 5-7, 5-8, 5-9, 5-10.

- a. Disconnect the coaxial cable connected to the mixer output terminal (Figure 5-7).
- b. Connect the milliwattmeter to this terminal and ground the coax braid to the adjacent printed circuit board.
- c. Set the channel selector to 135.50MHz (mc) and activate the transmitter.

Normal Indication: Mixer power output, 0.8 milliwatts minimum.

- d. If power is less than 0.8 milliwatts, adjust L-302 and L-306 for maximum output.
- e. Set the channel selector to 118.50MHz (mc) and adjust C-307 for maximum output.
- f. Repeat the procedure given in steps d and e until no increase in power is evident. The output level should be approximately equal at all MHz (mc) channels.
- g. Reconnect the coaxial cable to the mixer output terminal.

NOTE

Some change in the mixer adjustment may occur when the mixer output cable is connected to the first amplifier input.

- h. Connect the DC VTVM rf probe to the mixer output to monitor the output throughout the range. If required, repeat steps c, d, e, and f using the VTVM as the indicator.

5-22. First RF Amplifier Alignment (Q-303).

References: Schematic, Figure 7-1; Assembly Location, Figures 5-1 and 5-2; Parts location, Figures 5-10 and 5-25.

NOTE

Refer to Figure 5-10 for location of the first amplifier board (between shield partition and the second amplifier partition assembly), then to Figure 5-25 for location of components.

- a. Connect the diode probe of the DC VTVM to the insulated standoff terminating the base lead of Q-304.

Normal Indication: Nominal drive is approximately -0.7 volt RMS.

NOTE

The power output of this stage cannot be readily measured with the milliwattmeter. The stage gain is approximately 12 db with approximately 15 mw output.

If the drive measured at the input of the second rf amplifier is low, set the channel selector to 135MHz (mc) and adjust L-305 for maximum output.

- c. Set the channel selector to 118MHz (mc) and adjust C-314 for maximum output.
- d. Repeat steps b and c above until the maximum output is obtained.

5-23. Second R.F. Amplifier Alignment (Q-304).

References: Schematic, Figure 7-1; Assembly Location, Figures 5-1 and 5-2; Parts Location, Figure 5-10; Test Setup, Figure 5-26.

Procedure:

NOTE

The measurement of output power from the second rf amplifier requires connecting an impedance matching network between the amplifier and the milliwattmeter. This procedure is given in detail below.

- a. Disconnect the silver ribbon that ties C-320 to C-321, (unsolder from the tie point terminal on L-308).
- b. Use a 4-40 nut and lockwasher to secure the milliwatt meter matching network ground lug (Figure 5-26) to the stud at the center top of the third amplifier partition.
- c. Solder the 6.8 pf capacitor (center conductor of matching network) to the free end of the silver ribbon.
- d. Connect the matching network to the milliwatt meter through a 20 db pad. With the milliwatt meter set to the 3 mw range, the full scale reading (including the 20 db) now becomes 300 mw.
- e. Set the channel selector to 135.0MHz (mc) and adjust the test equipment impedance matching network for optimum performance as follows: With the transmitter activated (unmodulated) adjust the shunt trimmer for maximum power output as indicated by the milliwatt meter.
- f. Set the channel selector to 135.0MHz (mc) and adjust L-309 for maximum power output.
- g. Set the channel selector to 118.0MHz (mc) and adjust C-320 for maximum power output.
- h. Repeat steps f and g above, until no increase in power can be obtained.

Normal Indication: 110 milliwatts minimum, approximately the same level output on all full unit channels (MHz). Overall gain is approximately 10 db with approximately 150 mw output.

5-24. Third RF Amplifier Alignment (Q-305).

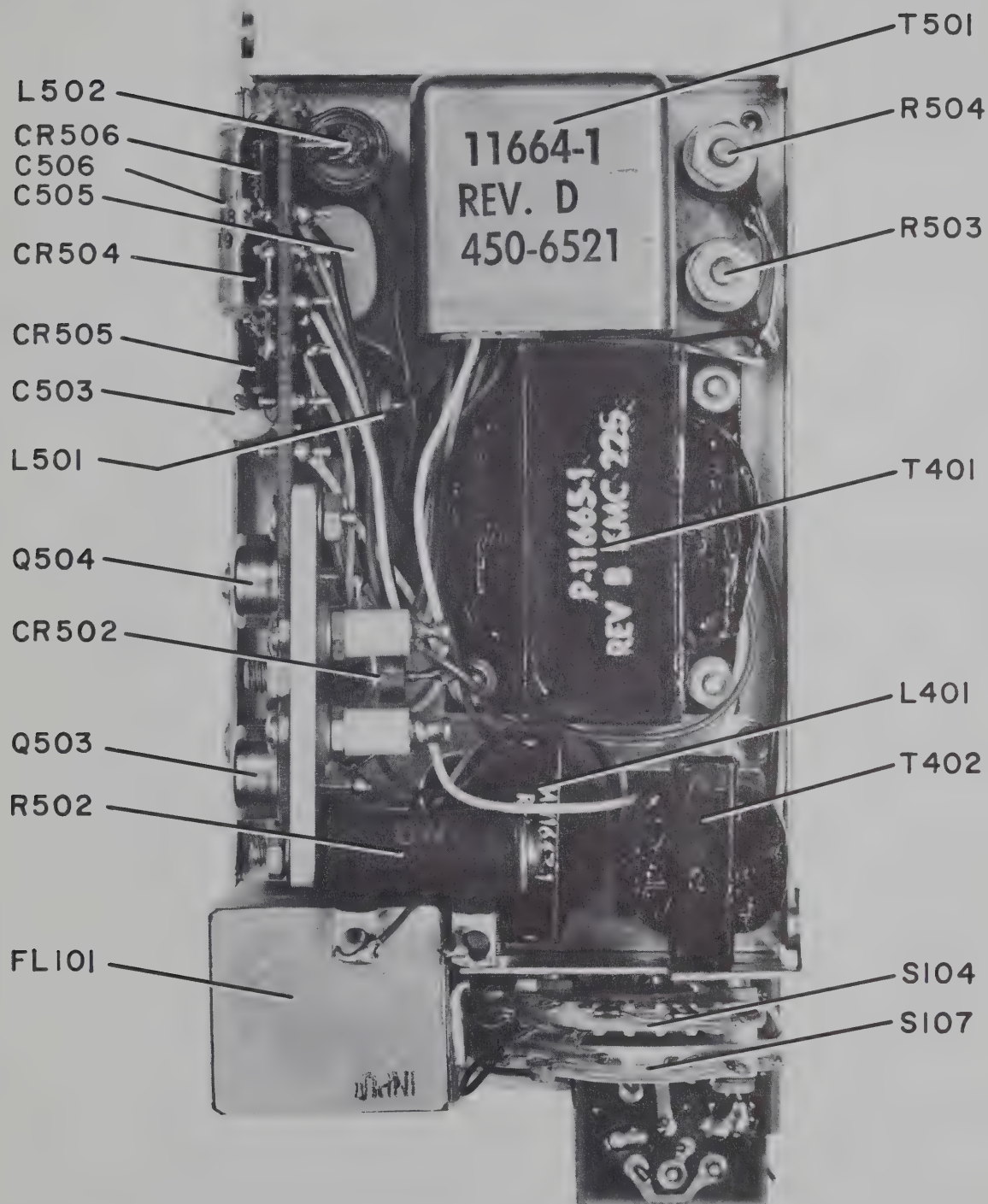
References: Schematic, Figure 7-1; Assembly Location, Figures 5-1 and 5-2; Parts Location, Figure 5-10.

Procedure:

NOTE

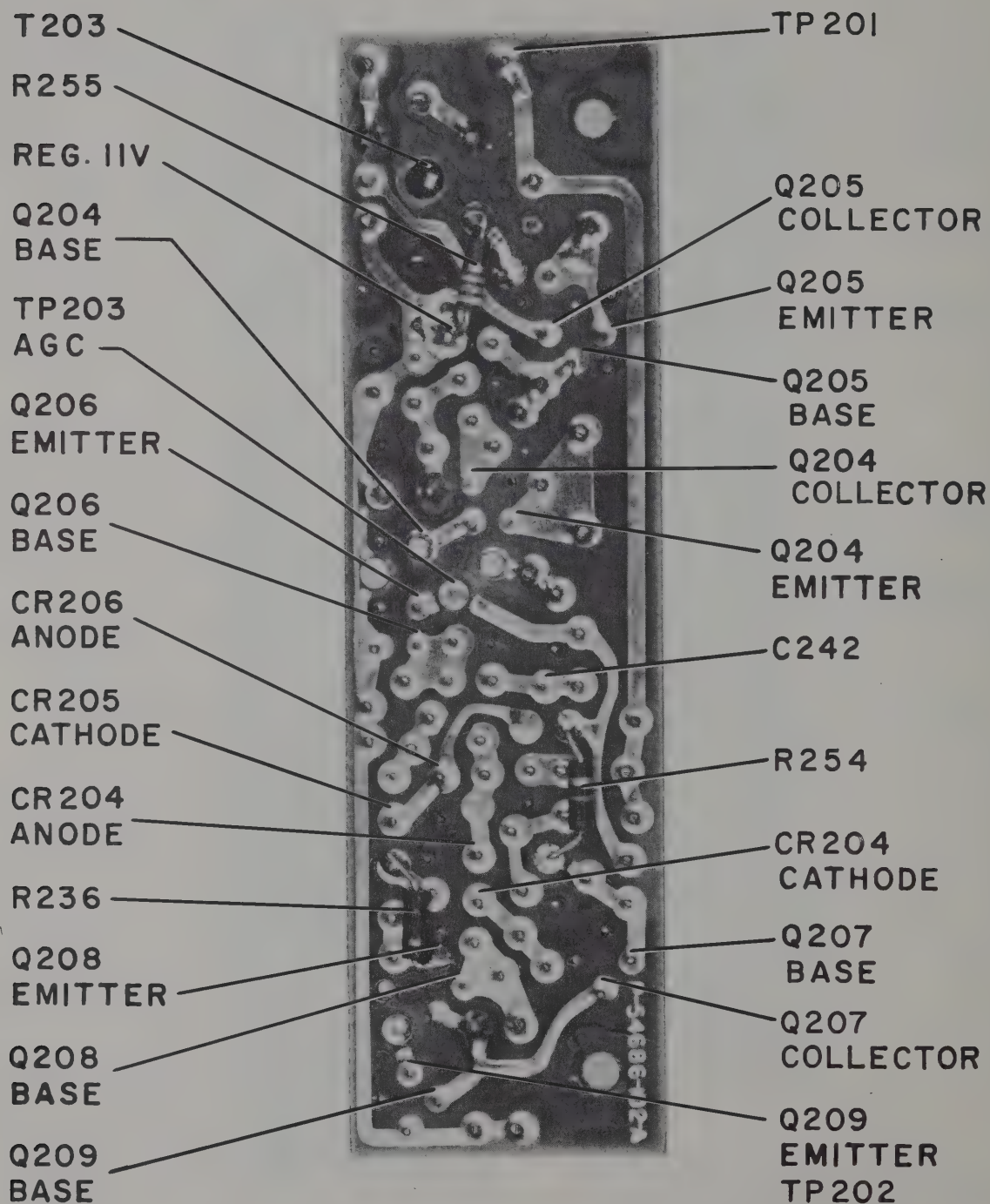
This procedure outlines two methods of metering the output during alignment. Either the driver dc base current or the driver emitter current through R-319 can be monitored.

- a. DC Base Current Measurement.
 1. Remove the two screws from the rear and two screws from the center left side panel to reach L-6, the shorting jumper.



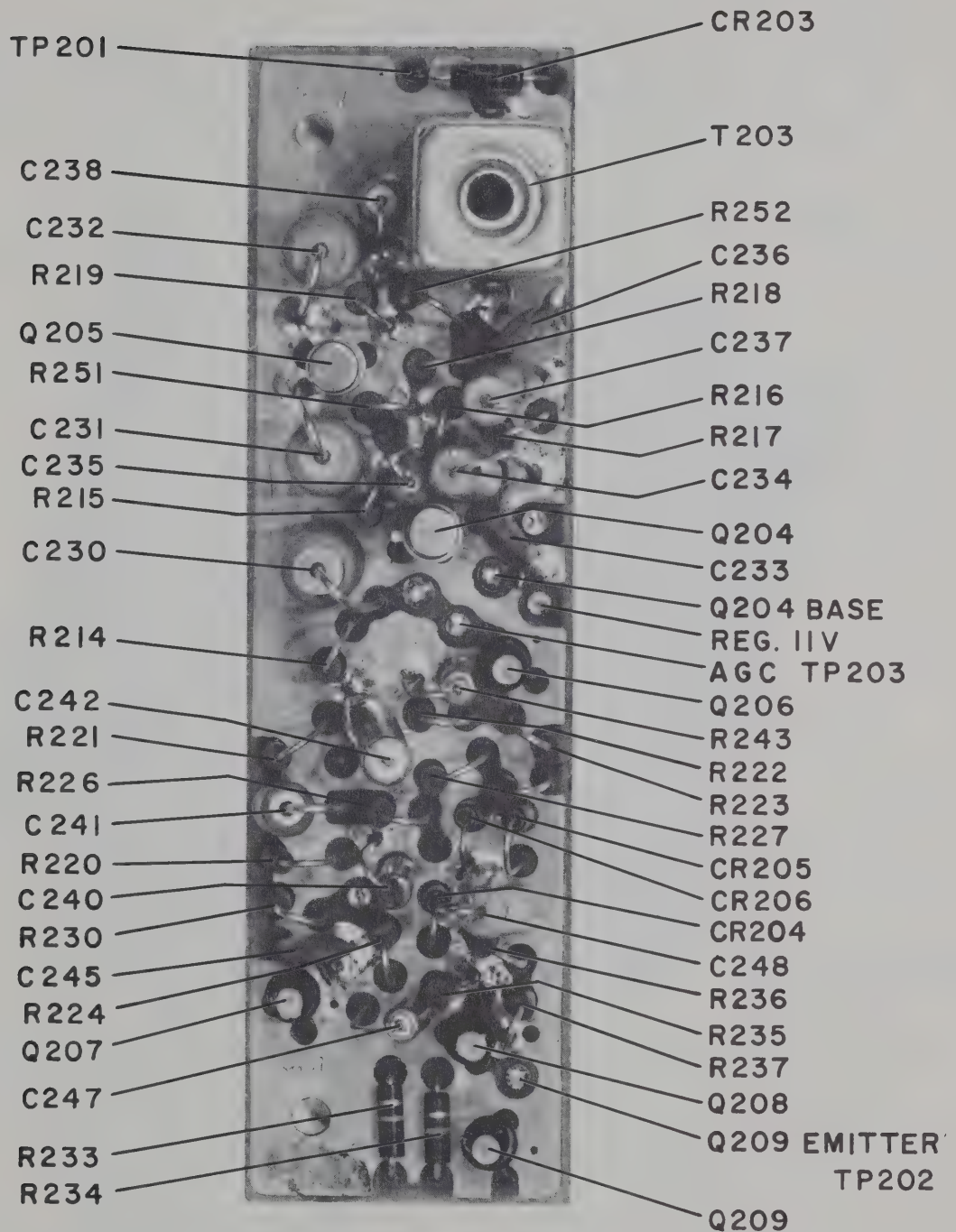
NAR-482

FIGURE 5-17. COMMON AUDIO AND DC-DC CONVERTER BOARD, BOTTOM VIEW



NAR-542

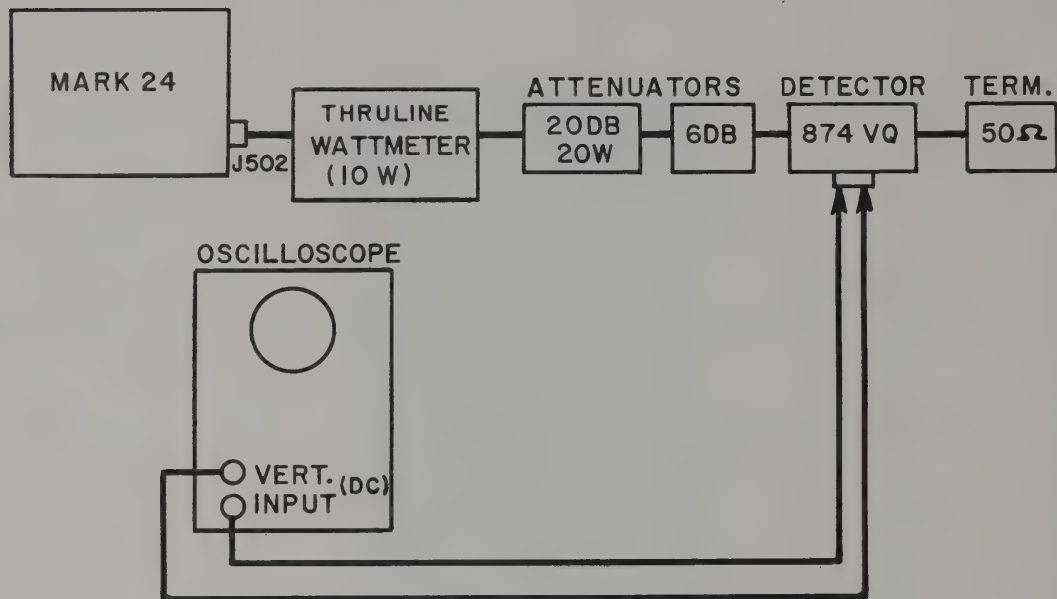
FIGURE 5-18. COM RECEIVER LFIF BOARD, TOP VIEW



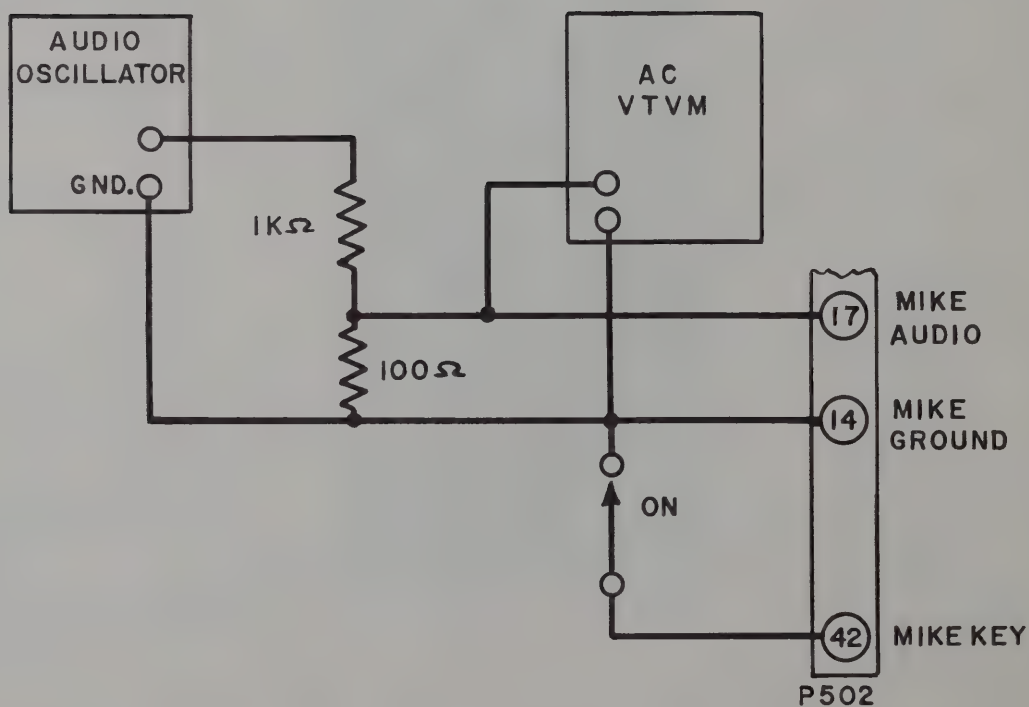
NAR-490

FIGURE 5-19. COM RECEIVER LFIF BOARD, BOTTOM VIEW

A.— TRANSMITTER TEST SETUP

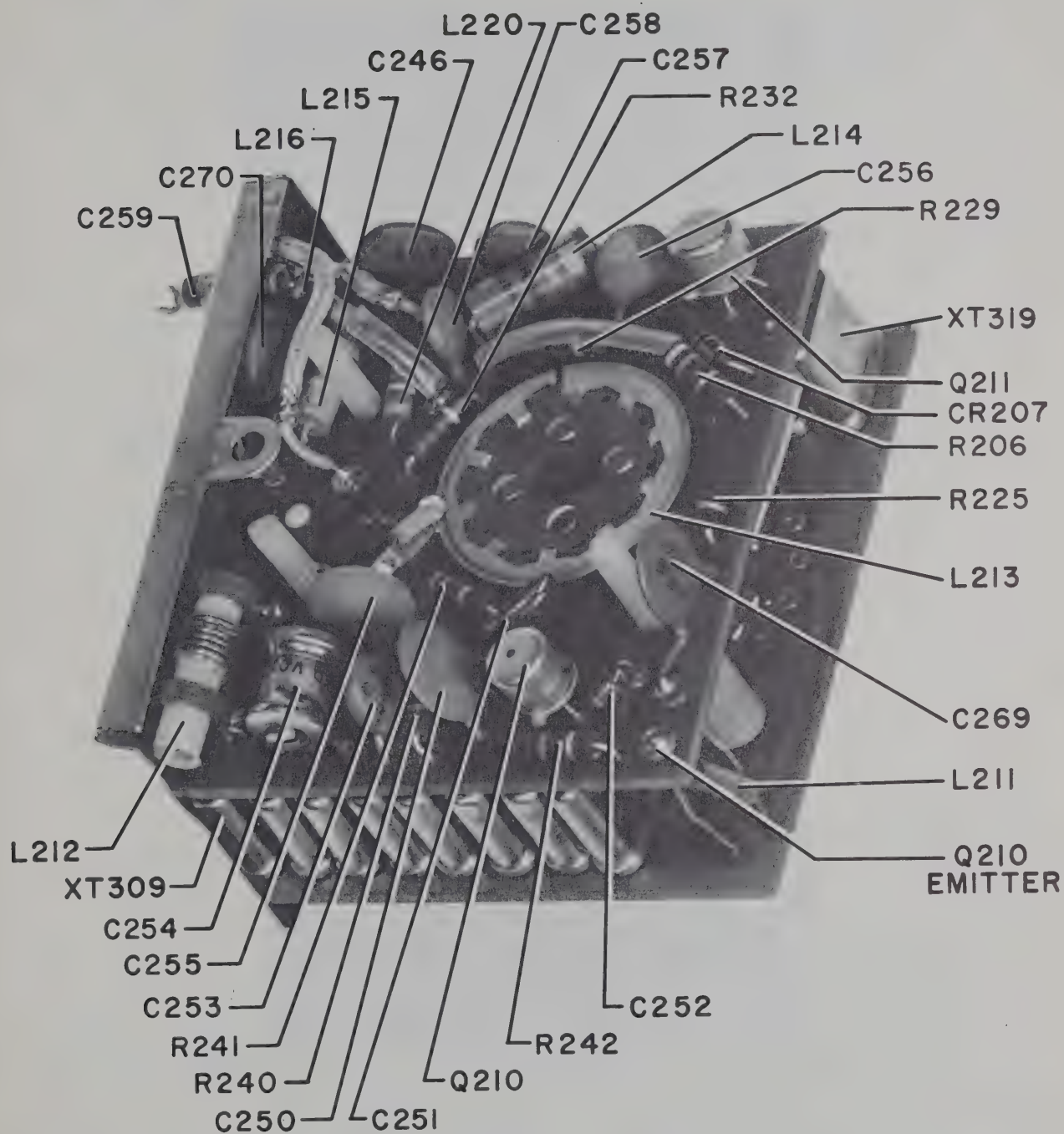


B.— % MODULATION MEASUREMENT



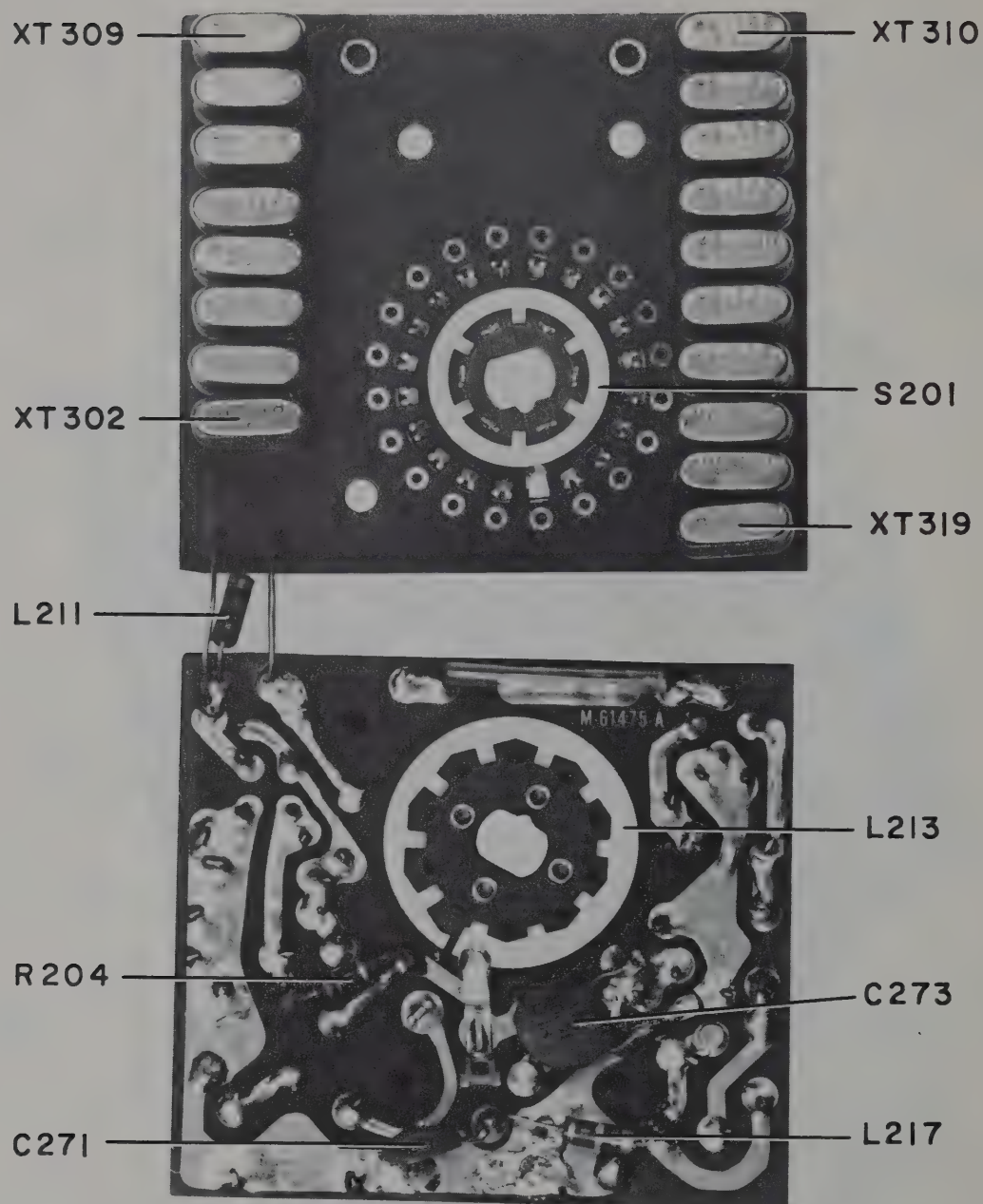
M-07228

FIGURE 5-20. COM TRANSMITTER, INTERCONNECTIONS FOR OUTPUT MEASUREMENTS



NAR-485

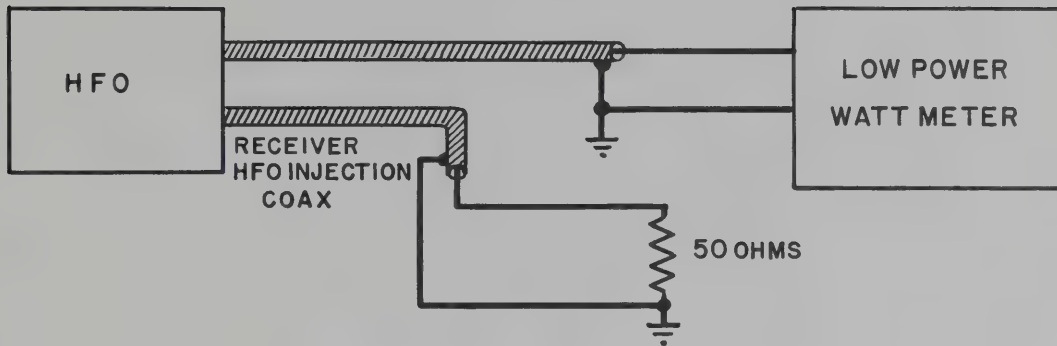
FIGURE 5-21. COM TRANSCEIVER HFO ASSEMBLY, TOP VIEW



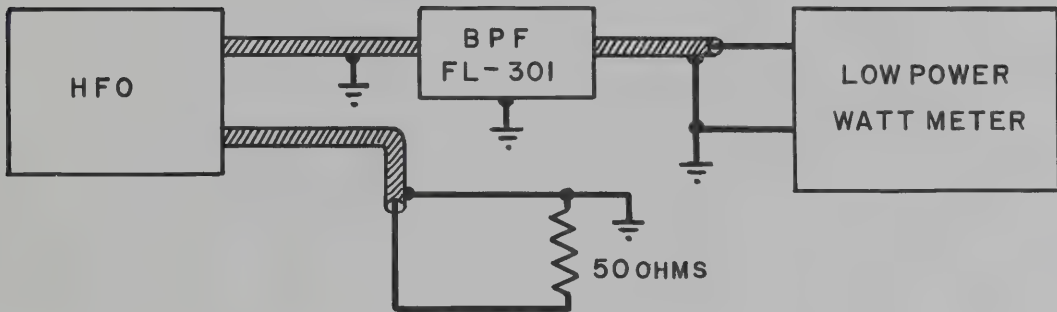
NAR-487

FIGURE 5-22. COM TRANSCEIVER HFO ASSEMBLY, FOLDED OPEN

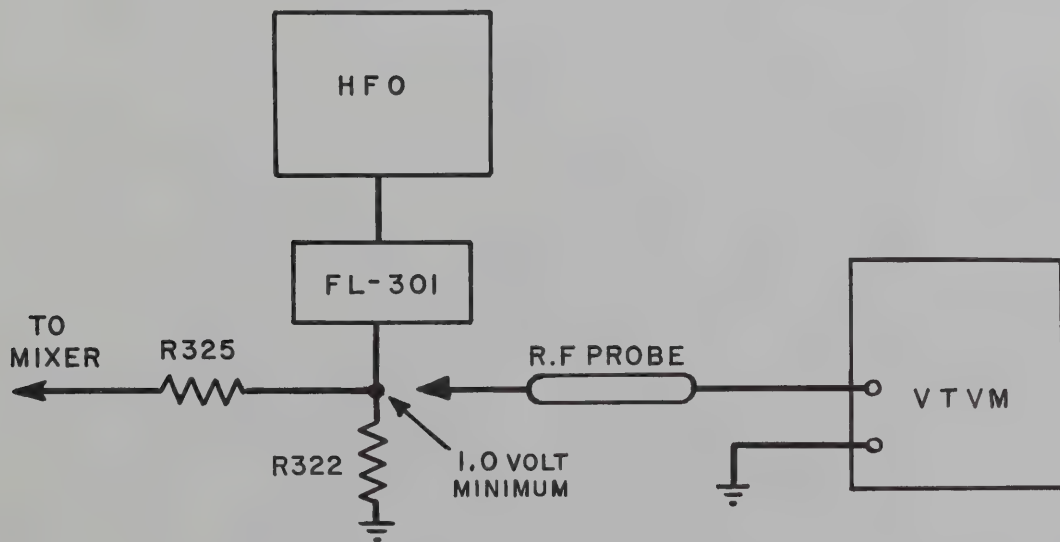
A.— HFO OUTPUT



B.— FL-30I OUTPUT

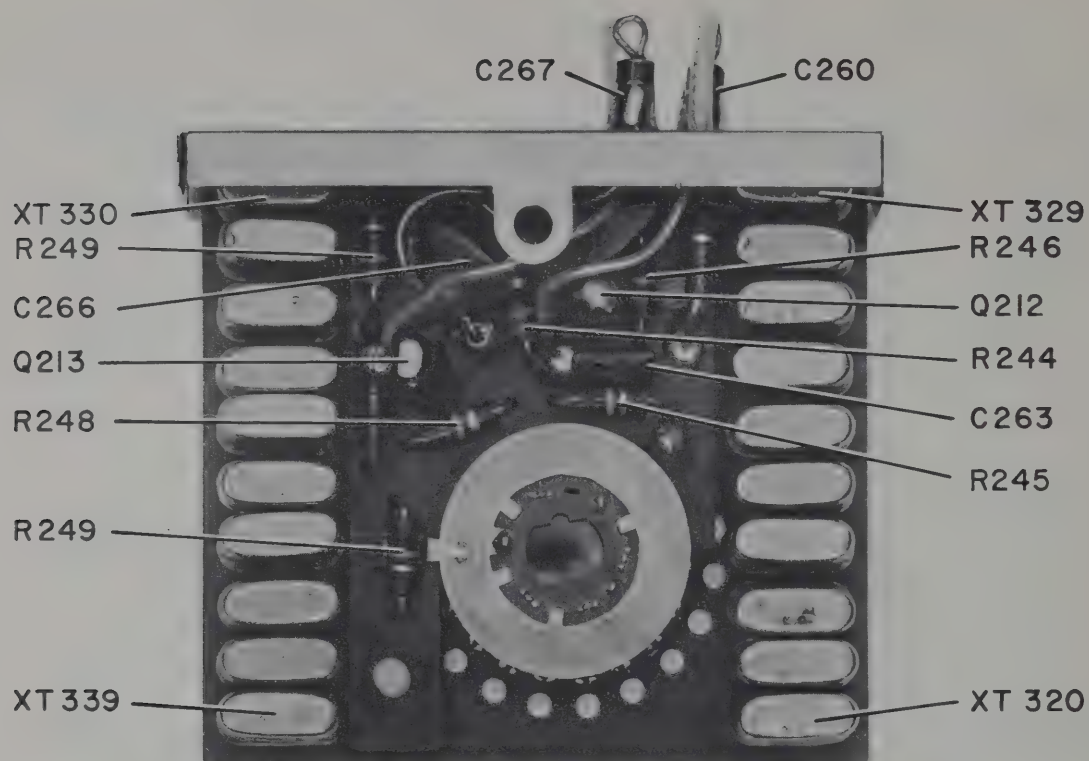


C.— TRANSMITTER HFO INJECTION VOLTAGE



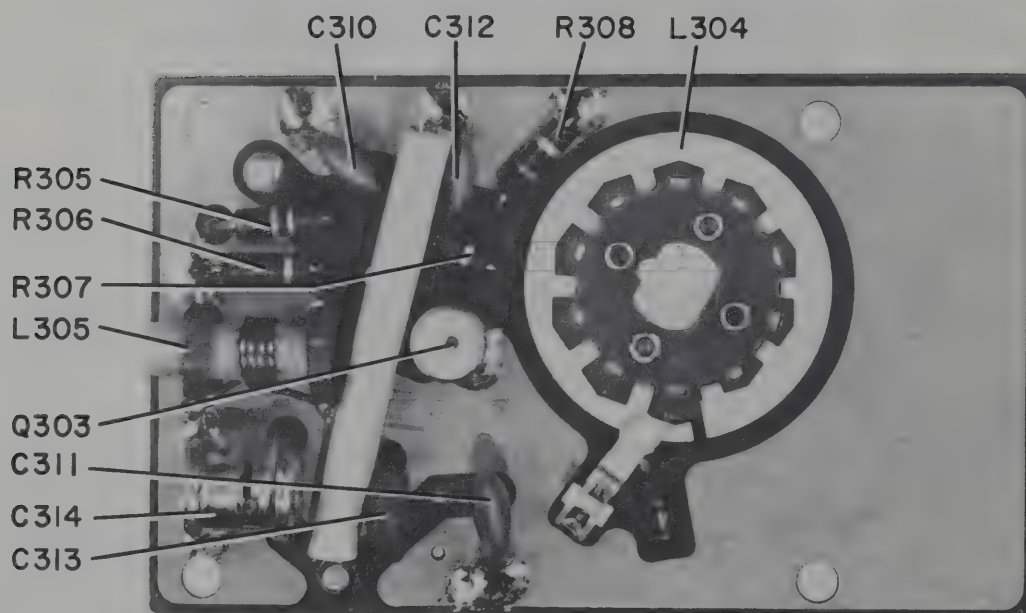
M-07227

FIGURE 5-23. COM TRANSMITTER TEST EQUIPMENT SETUPS



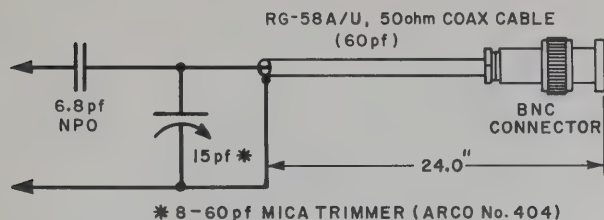
NAR-501

FIGURE 5-24. COM TRANSCEIVER, LFO ASSEMBLY



NAR-543

FIGURE 5-25. COM TRANSMITTER, FIRST RF AMPLIFIER BOARD



M-07229

FIGURE 5-26. RF MEASUREMENTS, IMPEDANCE MATCHING NETWORK

2. Remove the shorting jumper, that bridges C-331 to the ground lug.
3. Connect the milliammeter to the terminals of the shorting jumper.

Normal Indication: Between 7 and 15 milliamperes when the transmitter is activated.

b. Emitter current measurement.

1. Connect the DC VTVM across R-319.
2. Activate the transmitter and measure the drop across the 1 ohm resistor. The meter will also indicate current since it reads .001 volt for each .001 ampere current flow (i.e. 0.25 volt = 250 ma).

Normal Indication: Emitter voltage of +0.22 to +0.38 volts (with a very broad tuning peak); indicates adequate drive level from the third rf amplifier.

NOTE

The stage gain is 8 db with approximately 1 watt output.

- c. Alignment; Set the channel selector to 135.5MHz (mc) and adjust L-312 for maximum base current (step a) or maximum emitter current (step b) in Q-306.

5-25. RF Driver Amplifier Alignment (Q-306).

References: Schematic, Figure 7-1; Assembly Location, Figures 5-1 and 5-2; Parts Location, Figure 5-10.

Procedures:

NOTE

The driver output is monitored indirectly by measuring the dc emitter current of Q-307, the final amplifier.

- a. Connect the DC VTVM across R-320.
- b. Activate the transmitter and measure the drop across this 1 ohm resistor. The meter will also indicate current since it reads .001 volt for each .001 ampere current flow.

Normal Indication: Emitter voltage of +0.65 to +1.0 volts indicates adequate drive levels into the final amplifier.

NOTE

The stage gain is 3 db with approximately 2 watts output.

- c. Alignment; Set the channel selector to 127.5MHz (mc) and adjust L-315 for maximum overall output power as measured at the COMM antenna connector.

5-26. RF Final Amplifier Alignment (Q-307).

References: Schematic, Figure 7-1; Parts Location, Figure 5-10; Interconnections, Figure 5-20A.

Procedure.

- a. Connect the DC VTVM across R-320.
- b. Activate the transmitter and measure the drop across this 1 ohm resistor. The meter will also indicate current since it reads .001 volt for each .001 ampere current flow.

Normal Indication: Emitter voltage +0.65 to +1.0 volts indicates adequate power to the output circuit.

NOTE

The stage gain is 5 db with approximately 6 watts output at 118 and 135MHz (mc).

- c. Alignment; Set the channel selector to 127MHz (mc) and adjust L-318 for maximum power output as measured at the COM antenna connector.

5-27. Transmitter Modulation Adjustment.

- A. Microphone Input Voltage Adjustment. Connect as shown in Figure 5-2 and adjust the audio oscillator until the oscilloscope indicates just below clipping. The signal level should be within the 0.1 to 0.3 volt RMS range. If the meter reading is not within the above limits, the overall gain of the amplifier must be changed by selecting a new value for R-414. Remove R-414 from the NAV Receiver and LFIF board and proceed as follows:

1. Set the audio oscillator signal level within the 0.1 to 0.3 volt rms range as measured at the MIKE terminals of the connector (pins 14 and 17).
2. Connect the resistor substitution box in place of R-414 on the component board.
3. Vary the resistance until the oscilloscope indicates that the output is just below the clipping level.
4. Remove the resistor substitution box, measure the resistance across the terminals of the box, select an equivalent value resistor, and solder into the board in place of R-414.

NOTE

For 14 volt operation of the Mark-24 the value should be approximately 3.3K and for 28 volt operation approximately 8.2K ohms.

- B. % Modulation at Start of Clipping. Connect as shown in Figure 5-20 A and B and perform the test as directed below. Increase the audio signal until the oscilloscope indicates clipping. The percentage modulation at this point shall be 90% nominal (85% minimum).

PERFORM THE % MODULATION TEST AS FOLLOWS:

1. Connect the transmitter as shown in Figure 5-20.
2. Set the oscilloscope vertical input for DC operation and .2V/Division, internal sync.
3. Set the position of the oscilloscope trace two divisions below the horizontal center line on the graticule.
4. Key the transmitter modulation and adjust the oscilloscope vertical gain to position the unmodulated zero line two divisions above the horizontal center line on the graticule.

NOTE

When the transmitter is turned off, the trace must return to its initial position (two divisions below the horizontal center line on the graticule). When the transmitter is keyed once more, the trace will move a total of four divisions.

5. With the transmitter keyed, apply 1,000Hz (cps) modulation and adjust the modulation signal level for maximum unclipped amplitude on the oscilloscope.

$$\% \text{ Mod} = \frac{\text{maximum unclipped sine wave amplitude as observed on scope}}{4 (\text{No. of divisions unkeyed/keyed})}$$

$$\text{Example: } \frac{3.6 \text{ Div.}}{4 \text{ Div.}} = .9 \times 100 = 90\%$$

5-28. ALIGNMENT PROCEDURES, COM RECEIVER.

NOTE

Since the operation of this double conversion superheterodyne receiver is dependent upon the overall operation of many tuned circuits, it is necessary to tune and align the circuits in the sequence indicated below.

5-29. Low Frequency IF Amplifier (Q-204, Q-205) and Second Mixer (Q-203).

References: Schematic, Figure 7-1; Assembly Location, Figures 5-1 and 5-2; Parts and Test Point Location, Figures 5-11, 5-12, and 5-18.

Procedure for Q-204 and Q-205:

- a. Connect the rf signal generator output to the base of Q-204 through a .01 μ f coupling capacitor and connect the AC VTVM to TP-201.
- b. Set the rf signal generator frequency to 500kHz (kc), modulated 30% by 1kHz (kc) and increase the signal generator output until an indication is obtained on the AC VTVM.
- c. Adjust T-203 for maximum indication on the AC VTVM.

Normal Indication: With 15 μ volts input, the AC VTVM shall indicate a minimum of 0.1 volt rms at TP-201.

- d. Disconnect the coupling capacitor and the signal generator.

Procedure for Q-203:

- a. Connect the rf signal generator output to the base of Q-203 through a .01 μ f coupling capacitor and connect the AC VTVM to TP-201.
- b. Set the signal generator frequency to 500 kHz (Kc) modulated 30% by 1kHz (Kc) and increase the signal generator output until an indication is obtained on the AC VTVM.
- c. Adjust T-203 for maximum indication on the AC VTVM.

Normal Indication: With 5 μ volts input, the AC VTVM should indicate a minimum of 0.1 volt rms.

- d. Disconnect the 500kHz (kc) signal generator and connect the rf signal generator to the .01 μ f coupling capacitor.
- e. Rotate the fractional unit channel selector to the 0.50MHz (mc) position.
- f. Set the signal generator frequency to 18.975 MHz (mc) modulated 30% by 1kHz (kc) and increase the signal generator output until an indication is obtained on the AC VTVM.
- g. Check the tuning of T-203.

Normal Indication: With 5 μ volts input, the AC VTVM shall indicate a minimum of 0.1 volt rms at TP-201.

- h. Disconnect the signal generator and coupling capacitor from Q-203.

5-30. High Frequency IF and First Mixer (Q-202).

References: Schematic, Figure 7-1; Assembly Location, Figures 5-1 and 5-2; Parts and test point locations, Figures 5-11 and 5-12.

Procedure:

- a. Connect the rf signal generator output to the base of Q-202 through a .01 μ f coupling capacitor and connect the AC VTVM to TP-201.
- b. Rotate the fractional unit selector to the 0.50kHz (kc) position.
- c. Tune the rf signal generator to 18.975MHz (mc), modulated 30% by 1kHz (kc) and increase the signal generator output until an indication is obtained on the AC VTVM.
- d. Adjust T-201 and T-202 primary (bottom core) and secondary (top core) for maximum indication on the AC VTVM.

Normal Indication: With 10 μ volts input, the AC VTVM should indicate a minimum of 0.1 volts rms at TP-201.

- e. Rotate the fractional unit selector to the .00MHz (mc) position and set the signal generator frequency to 19.475 MHz (mc).
- f. Adjust the rf signal generator attenuator for 0.1 volt rms at TP-201. Note the input signal level required for this output.
- g. Rotate the fractional unit selector to the 0.95MHz (mc) position and set the signal generator fre-

quency to 18.525MHz (mc).

- h. Adjust the rf signal generator attenuator for 0.1 volt rms at TP-201. Note the input signal level required for this output.

NOTE

The input levels required for step f (19.475MHz) and step h (18.525MHz) should be less than 4 db apart.

- i. Increase the signal generator input level (or any fractional channel) until the AC VTVM at TP-201 reads 0.15 volts rms.
- j. Move the AC VTVM probe from TP-201 to TP-202.

Normal Indication: Nominal 0.22 volts rms at TP-202. The exact level will depend upon the value of R-236.

5-31. R.F. Amplifier (Q-201).

References: Schematic, Figure 7-1; Assembly Location, Figures 5-1 and 5-2; Parts and test point locations, Figures 5-11 and 5-12.

Procedure:

NOTE

The audio circuit must be properly operating before starting this alignment.

- a. Connect the rf signal generator to the COM antenna connector (J-502), the AC VTVM to TP-201, and the audio wattmeter to the audio output (speaker terminals, pins 14 and 16).
- b. Rotate the COM channel selector controls to the 135.50MHz (mc) position.
- c. Set the rf signal generator frequency to 135.50MHz (mc) modulated 30% by 1kHz (kc) and increase the signal generator output until there is an increase in the power indication at the wattmeter.
- d. With the signal generator output set below the level at which receiver AGC action takes place (below the knee of the AGC curve), tune L-201, L-203, and L-205 for maximum indication on the AC VTVM at TP-201 or on the audio wattmeter.
- e. Rotate the COM channel selectors to the 118.50 position.
- f. Set the rf MHz signal generator frequency to 118.50 MHz (mc) modulated 30% by 1kHz and increase the signal generator output until there is an increase in the power indication at the wattmeter.
- g. With the signal generator output set below the level at which receiver AGC action takes place, (below the knee of the AGC curve), tune C-204, C-209, and C-213 for maximum AC VTVM indication at TP-201 or on the audio wattmeter.

NOTE

The rf stages may be tracked while observing the audio output (speaker) if this level is kept at all times below its 5 watt rated output.

- h. Repeat steps b. thru g. until no further increase of receiver sensitivity is observed.
- i. With the COM receiver set to 118.50, 127.50, and 135.50MHz (mc) determine the rf signal gen-

erator output level required to obtain a $6 \text{ db } \frac{S + N}{N}$

at the audio output (speaker terminal's).

For each of the above frequencies perform the steps below in the order given:

1. Set the rf signal generator to one of the above frequencies modulated 30% by 1kHz (kc).
2. Set the COM receiver channel selector to the same channel.
3. With the signal generator output set for approximately 1 μ volt, adjust the COMM volume control for 2 watts at the audio output.
4. Remove modulation from the rf carrier and note the decrease below the 2 watt level.
5. Increase or decrease the signal generator output level as required to obtain a $6 \text{ db } \frac{S + N}{N}$ at the

audio output and note this level.

6. Repeat the above steps for each of the frequencies listed.

- j. Vary the value of R-253 to optimize the signal generator output level necessary to achieve a $6 \text{ db } \frac{S + N}{N}$

at the audio output for each of the channels specified above, with special attention given the channel requiring the greater signal generator output level for the $6 \text{ db } \frac{S + N}{N}$

Normal Indication: 1 μ volt for $6 \text{ db } \frac{S + N}{N}$ at the audio output.

Maximum Indication: 1.5 μ volt for $6 \text{ db } \frac{S + N}{N}$ at the audio output.

- k. R-255 is a select-by-test resistor (minimum value 10k), installed at the factory to provide the correct IF gain. If repairs have been performed on the 500kHz (kc) LFIF that will affect the overall gain, this procedure will control the LFIF gain. Retuning of T-203 does not require that R-255 be adjusted.
1. Select any of the COM channels for this procedure.
2. Set the signal generator to this frequency, modulated 30% by 1kHz (kc).
3. With the signal generator output set to 10 millivolts, adjust the volume control to provide 5 watts of audio output.
4. Rotate the signal generator frequency control so as to sweep rapidly through the receiver channel.
5. Quickly return to the original frequency. If there is no audio signal present, the fault is blocking of the detector (CR-203).
6. Lower the value of R-255 and repeat the above procedure until a value has been selected that will not permit blocking of the detector. The value of this resistor will be greater than 10K ohms.

1. Selection of R-236. This resistor is selected with the

receiver tuned to the channel requiring the highest level signal generator output for a 6 db $S + \frac{N}{N}$ at

the audio output. With the volume control (R-239) set to the maximum CW position and an input signal of 1.5 to 2.0 μ volts, R-236 is selected to produce 5 watts at the audio output.

m. Squelch Compensation.

1. Select the operating channel requiring the highest level of signal generator output for a 6 db $S + \frac{N}{N}$ at the audio output as described in step i of this paragraph.
2. Increase the signal generator output to 25 μ volts and set the COM receiver volume control for 5 watts audio output power.
3. Rotate the squelch control to its maximum CCW position and select the value of R-254 that permits squelch action (audio output) with 25 to 30 μ volts of rf signal generator output.

n. FM Filter Adjustment.

1. Set the COM channel selector to any of the COM channels.
2. Adjust the signal generator to approximately 96MHz (mc) modulated 30% by 1 kHz (kc) and increase the output level to approximately 200 millivolts.
3. Vary the signal frequency around 96 MHz (mc) until an audio indication is obtained from the COM receiver.
4. Tune L-219 for minimum audio output as indicated at the AC VTVM.

5-32. COM Low Frequency Oscillator (Q-213).

References: Schematic, Figure 7-1; Assembly Location, Figures 5-1 and 5-2; Parts Location, Figure 5-24.

NOTE

The oscillator must be in its shield box during all power and frequency measurements.

Procedure:

- a. Disconnect the desired coax output cable and connect to the low power rf milliwattmeter through a 0.01 μ f capacitor.
- b. Apply +11 volts dc to the exposed lead of the appropriate feed-thru capacitor; C-267 for the receive LFO and C-260 for the transmit LFO.

CAUTION

If the oscillator has been removed from the receiver, use an external power supply. This will protect the +11 volt regulated supply of the Mark-24 from damage due to overloads or short circuits.

Normal Indication: Nominal 1.5 milliwatts $\pm$ 2 DB.

- c. Frequency Check. Disconnect the LFO output coax and 0.01 μ f coupling capacitor from the milliwattmeter and connect to the frequency counter.

Refer to table 4-1 for the frequency limits. Be sure to select the proper sequence (transmit or receive).

5-33. COM High Frequency Oscillator Q-210, Q-211).

NOTE

If the COM HFO has been aligned as described in paragraph 5-17 of the transmitter alignment procedure, the procedure given below is not required.

References: Schematic, Figure 7-1; Assembly Location, Figures 5-1 and 5-2; Parts Location, Figures 5-21, and 5-22.

CAUTION

If the oscillator has been removed from the receiver, use an external power supply. This will protect the +11 volt regulated supply of the Mark-24 from damage due to overloads or short circuits.

Procedure:

NOTES

With COM HFO *removed* from MK-24;

- (1) Refer to Figure 5-1 for orientation of S-201 and direction of rotation for ascending frequencies.
- (2) Use external +11 volts dc supply (refer to caution above).
- (3) The oscillator must be in its shield box during all power and frequency measurements.
- a. Remove the HFO transmitter injection coax from the input of FL-301 and connect to the low power milliwatt meter. A length of low capacitance coax, not to exceed 12 inches, may be used.
- b. Remove the HFO receiver injection coax from the input of Q-202 (Figure 5-11) and terminate with a 51 ohm $\frac{1}{4}$ watt resistor connected from center conductor to braid.
- c. Connect to +11 volts dc as directed in the NOTES above.
- d. Rotate the channel selector to the 118MHz (mc) position. If the HFO has been removed from the MK-24, refer to the NOTES above.
- e. Adjust C-254 for maximum power output.
- f. Rotate the channel selector to the 135MHz (mc) position and adjust L-212 for maximum power output.
- g. Repeat steps d. to f. until no further increase of power can be seen.
- h. Check the power output at all crystal positions.
Normal Indication: 15 milliwatts $\pm$ 3db.
- i. Disconnect the rf milliwattmeter from the transmitter injection coax and connect to the receiver injection coax. Terminate the unused coax with the 50 ohm resistor.
- j. Check the power output at all crystal positions.
Normal Indication: 500 microwatts $\pm$ 3 db.
- k. Remove the rf wattmeter and substitute a frequency counter. Refer to table 4-1 for the COM channel frequency limits.

NOTE

The frequency counter may be connected to either HFO output cable; however, the unused cable must be terminated with a 50 ohm $\frac{1}{4}$ watt resistor.

5-34. ALIGNMENT PROCEDURES, NAV RECEIVER.

5-35. Low Frequency IF Amplifier (Q-104, Q-105).

References: Schematic, Figure 7-1; Assembly Location, Figure 5-2; Parts Location, Figures 5-15, 5-16; Interconnections, Figure 5-27.

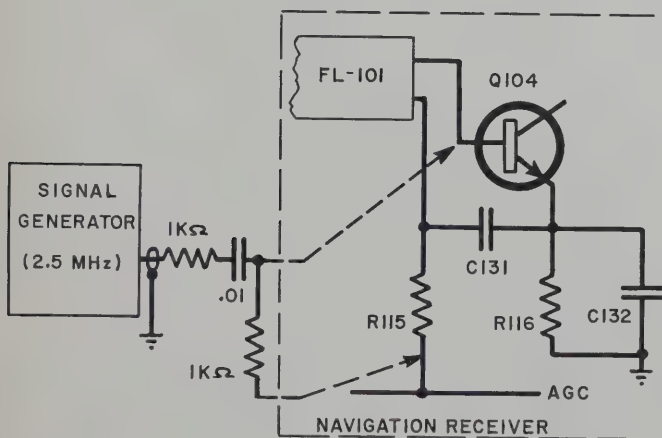
- Remove the coax center conductor from the base terminal of Q-104.
- Connect the signal generator and bias network to the Q-104 input as shown in Figure 5-27.
- Connect the AC VTVM to the exposed lead of R-123. This lead is connected to TP-101, which is the output of diode detector CR-101.
- Set the signal generator frequency to 2.5MHz (mc), modulated 30% by a 1 kHz (kc) signal and adjust the attenuator until an indication is obtained on the AC VTVM.
- Adjust T-102 for maximum indication on the AC VTVM.

Normal Indication: With 100 μ volts at the input, 0.1 volt RMS is indicated at CR-101.

- Adjust the input signal level to provide 0.1 volt RMS at TP-101. Remove the AC VTVM from TP-101 and connect to TP-103.

Normal Indication: 0.10 volts RMS at TP-103.

- Remove the input signal matching network shown in Figure 5-27. Reconnect the coax from FL-101 to the base of Q-104.



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FIGURE 5-27. LFIF AMPLIFIER ALIGNMENT INTERCONNECTIONS

5-36. Second Mixer (Q-103).

References: Schematic, Figure 7-1; Assembly Location, Figures 5-1 and 5-2; Parts Location, Figure 5-13.

Procedure:

- With a .01 μ f series capacitor in the signal generator output, connect this cable to the exposed lead of R-113.
- Set the rf signal generator to 2.5MHz (mc) modulated 30% by 1kHz (kc).
- Connect the AC VTVM to TP-103 and adjust the rf signal generator output until an output indication is obtained.
- Adjust T-102 for maximum indication on the AC VTVM.

Normal Indication: With 5 μ volts at the input, the AC VTVM connected to TP-103 shall indicate 0.1 volt RMS.

- Set the fractional unit channel selector to the 0.5 position and tune the rf signal generator to 16.01 MHz (mc) 30% modulated by 1kHz (kc).
- Adjust the rf signal generator output until an output indication is obtained; then check the tuning of T-102.

Normal Indication: With 15 μ volts at the input, the AC VTVM connected to TP-103 indicates 0.1 volt rms.

- Disconnect the rf signal generator, .01 μ f capacitor.

5-37. HFIF and First Mixer (Q-102).

References: Schematic, Figure 7-1; Assembly Location, Figures 5-1 and 5-2; Parts Location, Figures 5-13 and 5-14.

Procedure:

- Connect the signal generator to the junction of C-110 and C-114 and connect the AC VTVM to TP-103.
- Set the channel selector to the 113.9MHz (mc) position.
- Set the rf signal generator frequency to 16.41 MHz (mc) modulated 30% by 1kHz (kc) and adjust the attenuator for an indication at the AC VTVM.
- Adjust L-105 and T-101 primary (top core) and secondary (bottom core) for maximum signal as indicated by the AV VTVM.
- Set the fractional unit channel selector control to the .0MHz position.
- Set the signal generator frequency to 15.51 MHz (mc) modulated 30% by 1kHz (kc) and adjust the signal generator output for an indication at the AC VTVM.
- Adjust capacitors C-122 and C-126 for maximum signal as indicated by the AC VTVM.

NOTE

Trimmer capacitors C-122 and C-126 exhibit two peak signal positions when rotated through 360°. Although either peaking position may be used the trimmers must be rotated to confirm the presence

of two peaks. If only one tuning peak is present the capacitors are at either minimum or maximum capacitance and the circuit will be improperly tuned.

- h. Repeat steps c., d., e., f., and g., above until no further increase is noted.

Normal Indication: With 15 μ volts at the input, the AC VTVM connected to TP-103 indicates 0.1 volt rms.

- i. Set the channel selector to 112.9MHz (mc).
j. Set the rf signal generator to 11.41MHz (mc) 30% modulated by 1kHz (kc) and adjust the signal generator output for an indication on the AC VTVM.
k. Adjust C-119 and C-123 for maximum indication on the AC VTVM.

NOTE

Trimmer capacitors C-119 and C-123 exhibit two peak signal positions when rotated through 360°. Although either peaking position may be used, the trimmers must be rotated to confirm the presence of two peaks. If only one tuning peak is present the capacitors are at either minimum or maximum capacitance and the circuit will be improperly tuned.

1. Set the fractional channel selector to the 0.0MHz (mc) position.
m. Set the rf signal generator to 10.51MHz (mc) modulated 30% by 1kHz (kc) and adjust the attenuator for 0.1 volt rms at the AC VTVM.

CAUTION

Do not adjust T-101 to track the low band of the HFIF.

NOTE

Capacitors C-119 and C-123 may be adjusted to balance the output levels between 0.0 and 0.9 of the fractional channel selector control of the low band of the HFIF.

Normal Indication: With 10 μ volts at the input, the AC VTVM connected to TP-103 shall indicate 0.1 Volt RMS.

- n. Set the channel selector to 113.5MHz (mc).
o. Set the rf signal generator frequency to 113.5MHz (mc) modulated 30% by 1kHz (kc) and adjust the signal generator output for 0.1 volt rms at the AC VTVM.
p. Adjust L-105 for a maximum indication at the AC VTVM.

Normal Indication: With 10 μ volts input, the AC VTVM connected to TP-103 shall indicate 0.1 volt rms.

- q. Disconnect the rf coax cable.

5-38. RF Amplifier (Q-101).

References: Schematic, Figure 7-1; Assembly Location, Figures 5-1 and 5-2; Location of parts, Figures 5-13 and 5-14; Interconnections, Figure 5-28.

Procedure:

NOTE

In the procedure given below, the audio section must be performing normally.

- a. Connect the rf signal generator and AC VTVM as shown in Figure 5-28.
b. Set the NAV channel selectors for 117.5MHz (mc) modulated 30% by 1kHz (kc) and adjust the attenuator for an increase in the power indication at the wattmeter while remaining below the knee of the receiver AGC curve.
c. Adjust L-101, L-103, and L-105 for maximum indication at the AC VTVM or the wattmeter.
d. Set the channel selector to 108.5MHz (mc).
e. Set the rf signal generator to 108.5MHz (mc) modulated 30% by 1kHz (kc) and adjust the attenuator for an increase in the power indication at the wattmeter.
f. Adjust C-103, C-109, and C-114 for maximum indication on the AC VTVM or the wattmeter.
g. Repeat steps b through f until no further increase of signal can be obtained.
h. Set the channel selector for 108.5, 113.5, 117.5 MHz (mc) and determine the signal generator input level necessary to obtain 6 db $\frac{S + N}{N}$.

NOTE

The 6db S + N is determined as follows:

1. Set the NAV channel selectors to desired channel.
 2. Set the signal generator to same frequency, 30% modulation by 1kHz(kc).
 3. Set signal generator output to 1 μ volt and adjust volume control for 2 watt audio output.
 4. Remove modulation and note decrease below 2 watt output reference level.
 5. If this difference is more or less than 6 db, increase or decrease the signal generator output as required and repeat the above until; the output difference is exactly 6 db.
- i. Vary the value of R-112 to optimize the level of signal generator input necessary to obtain 6 db $\frac{S + N}{N}$ at the audio output for each of the channels specified above. Note the channel requiring the greater signal level that provides 6 db $\frac{S + N}{N}$.

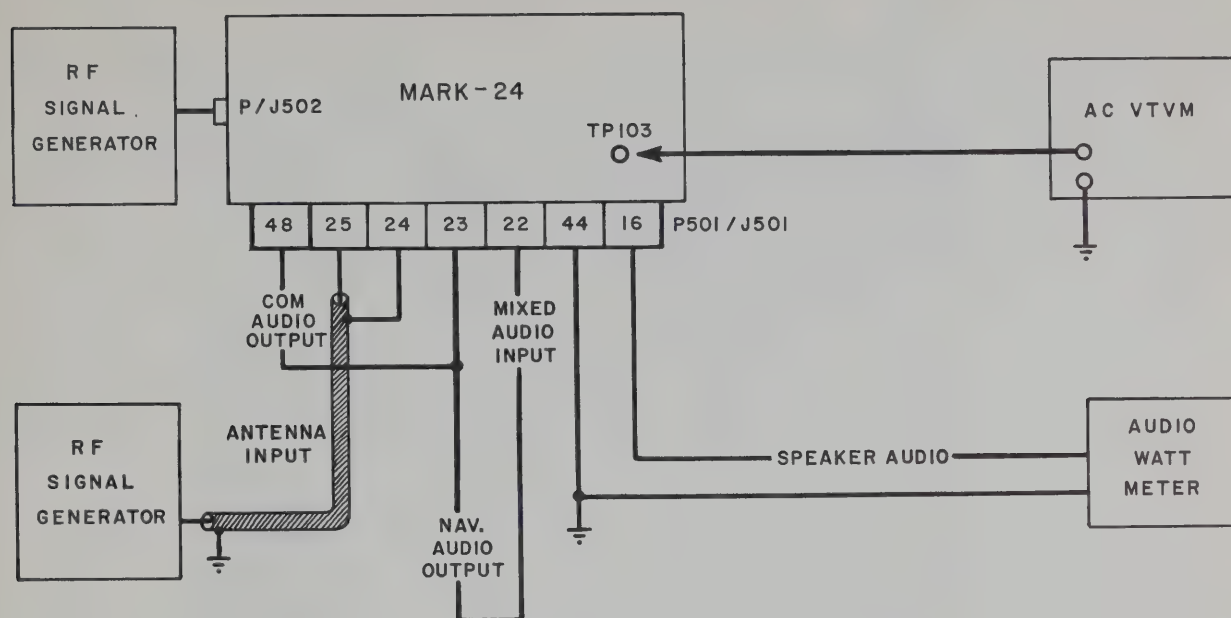
Normal Indication: 1 μ volt for 6 db $\frac{S + N}{N}$ at the audio output.

Maximum Indication: 1.5 μ volt for 6 db $\frac{S + N}{N}$ at the audio output.

- j. Rotate the NAV volume control in the CW direction to produce 5 watts of audio output under the conditions specified below:

Normal Indication: 1 μ volt for 6 db $\frac{S + N}{N}$ with 5 watts output.

Maximum Indication: 2 μ volts for 6 db $\frac{S + N}{N}$ with 5 watts output.



M-07232

FIGURE 5-28. RECEIVER, OVERALL TEST SETUP

5-39. NAV IDENT Filter.

References: Schematic, Figure 7-1; Parts Location, Figure 5-4; Interconnections, Figure 5-28.

Procedure:

- Connect the NAV receiver as shown in Figure 5-28.

NOTE

- The AC VTVM is not required in this procedure.
- Set the NAV channel selectors to any NAV frequency; set the rf signal generator to the same frequency, modulated 30% by 1020Hz (cps).
- Adjust the rf signal generator output for 1.0 millivolt rf output and adjust the volume control for 5 watts at the audio output.
- Actuate the IDENT filter switch (S-108) and note the decrease in audio output.
- Adjust L-109 for minimum audio output.

Normal Indication: 15 db rejection of the 1020Hz (cps) signal.

NOTE

R-134 may be 220 or 270 ohms. This resistor may be changed to obtain the desired rejection of the 1020Hz (cps) signal.

5-40. NAV High Frequency Oscillator (Q-110).

References: Schematic, Figure 7-1; Assembly Location, Figures 5-1 and 5-2; Parts Location, Figure 5-29; Switch Wafer Detent Indexing, Figure 5-3; Crystal Frequencies, Table 4-3.

Procedure:

- Disconnect the HFO injection coax from the Q-102 input network and connect to the bolometer (or rf milliwatt meter).

NOTE

If additional coax is required, the overall length should not exceed 12 inches of low capacitance coax cable.

- Apply 11 volts dc to the exposed lead from C-156; operating power may be obtained from the receiver's power supply or an external power supply.

CAUTION

If the HFO has been removed from the receiver, overload or accidental shorting of the +11 volt buss will damage the MK-24 voltage regulator. The use of an external power source is recommended.

- For oscillator retracking, adjust C-154 so that the head of the set screw is flush with the body of the capacitor and proceed as follows:
 - Oscillator located in the MK-24. Rotate the channel selector to 112MHz (mc) position and adjust L-111 for maximum power out. With channel selector in 108MHz (mc) position, adjust C-154 for maximum output. Repeat until no further increase is observed.
 - Oscillator removed from the MK-24. Refer to Figures 5-3 and 5-29 for the lowest crystal frequency setting and direction of rotation for ascending frequency. Rotate S-102/L-112 four

positions CCW from the low frequency position (101.49MHz) and adjust L-111 for maximum power output. Rotate S-102/L-112 to the starting position (97.94MHz), and adjust C-154 for maximum output power, repeat the above until there is no increase of output.

NOTE

During the HFO tuning and frequency measuring procedures, the oscillator shield box must be secured in position.

Normal Indication: $150 \mu\text{watts} \pm 2\text{DB}$.

- d. Frequency Check. Remove the milliwattmeter and connect the frequency counter to the HFO output. Refer to Table 4-3 for crystal oscillator frequencies. If the oscillator has been removed from the MK-24 for repairs, refer to Figures 5-3 and 5-29 for the lowest crystal frequency setting and the direction of rotation for ascending frequency.

5-41. NAV Low Frequency Oscillator (Q-111).

References: Schematic, Figure 7-1; Assembly Location, Figures 5-1 and 5-2; Parts Location, Figure 5-30; Switch wafer Detent Indexing, Figure 5-3. Oscillator Frequencies Table 4-3.

Procedure:

- a. Disconnect the LFO injection coax cable from the Q-103 input network and with a $0.01\mu\text{f}$ capacitor

in series, connect this output cable to the bolometer or an equivalent low power milliwattmeter.

- b. Apply 11 volts dc to the exposed lead from C-160; operating power may be obtained from the receiver power supply or from an external power supply.

CAUTION

If the LFO has been removed from the receiver, overload or shorting of the +11 volt buss will damage the MK-24 voltage regulator. The use of an external power source is recommended.

- c. If the oscillator has been removed from the MK-24 refer to Figure 5-30 and Figure 5-3 for lowest frequency setting and direction of rotation for the ascending frequency.

NOTE

The oscillator shield box must be secured in place before making any power measurements.

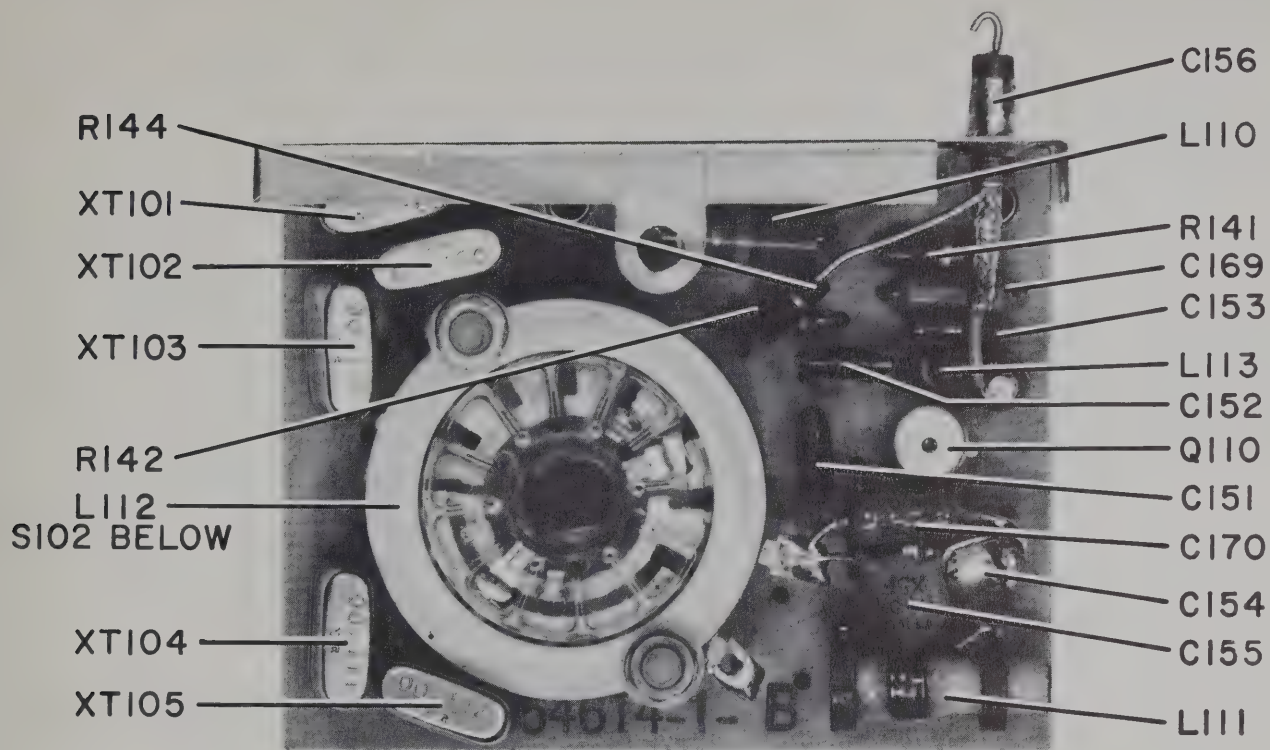
Normal Indication: $1 \text{ milliwatt} \pm 2\text{db}$.

- d. Remove the milliwattmeter from the output cable and connect to the frequency counter. The $.01\mu\text{f}$ capacitor must remain in series with the output.
- e. Refer to step c and table 4-3 for LFO frequencies.

NOTE

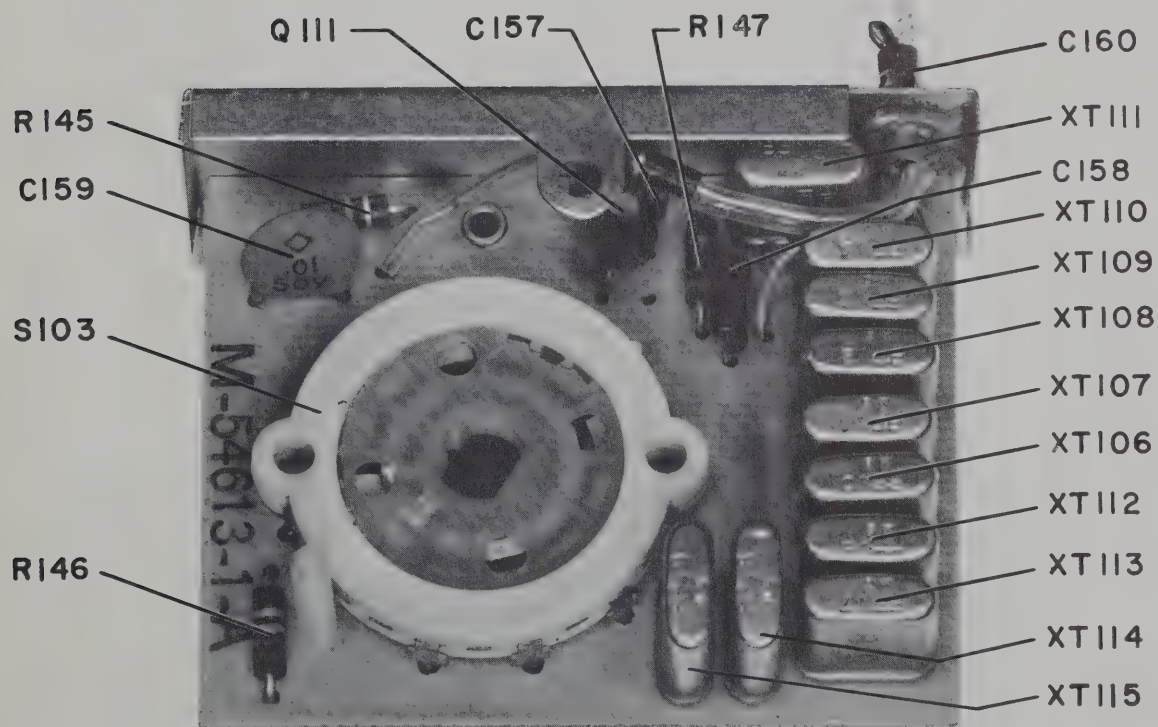
The oscillator shield box must be secured in place before making any frequency measurements.

- f. Disconnect all test equipment and reconnect the LFO injection coax cable.



NAR-500

FIGURE 5-29. NAV RECEIVER HFO ASSEMBLY



NAR-488

FIGURE 5-30. NAV RECEIVER, LFO ASSEMBLY

narco MARK-24

SECTION 6
PARTS LIST

6-1. INTRODUCTION.

This list of replacement parts contains the items that may be considered replaceable in the field. They should preferably be ordered by Symbol No. Part No., and Description.

The replacement parts are listed by their symbol letter and number, alphabetically then numerically. The

Symbol No. and value of the electrical components also appear in the parts location photographs of Section 5 and on the schematic. Some items without a Symbol No. are listed numerically by Part Number in a "Miscellaneous" list following the listings by symbol numbers. A few items without a Symbol No. may be listed with associated parts such as connectors.

6-2. PARTS LIST.

SYMBOL	NARCO PART NO.	DESCRIPTION
C, CAPACITORS		
C-101	24049-680	Capacitor, Dipped Mica, 68pf, $\pm 5\%$
C-102	24516-689	Capacitor, Ceramic Disc., 6.8pf, $\pm 0.5\text{pf}$, NPO
C-103	22019-1	Capacitor, Ceramic Variable, 0.5-4.5pf
C-104	24516-479	Capacitor, Ceramic Disc., 4.7pf, $\pm 0.5\text{pf}$, NPO
C-105	24516-120	Capacitor, Ceramic Disc., 12pf, $\pm 10\%$, NPO
C-106	21555-26	Capacitor, Solid Tant., 10 μf , $\pm 10\%$, 20 VDC
C-107	21291-25	Capacitor, Ceramic Disc., 430pf, $\pm 10\%$, X5F
C-108	24516-339	Capacitor, Ceramic Disc., 3.3pf, $\pm 0.25\text{pf}$, NPO
C-109	22019-1	Capacitor, Ceramic Variable, 0.5-4.5 pf
C-110	24509-338	Capacitor, Ceramic, .33pf, $\pm 5\%$
C-111	21291-25	Capacitor, Ceramic Disc., 430pf, $\pm 10\%$, X5F
C-112	21291-25	Capacitor, Ceramic Disc., 430pf, $\pm 10\%$, X5F
C-113	24516-689	Capacitor, Ceramic Disc., 6.8pf, $\pm 0.5\text{pf}$, NPO
C-114	22019-1	Capacitor, Ceramic Variable, 0.5-4.5 pf
C-115	21291-21	Capacitor, Ceramic Disc., 1000pf, $\pm 20\%$, Z5U
C-116	24049-120	Capacitor, Dipped Mica, 12pf, $\pm 0.1\text{pf}$
C-117	23089-63	Capacitor, Mylar, 0.01 μf , $\pm 10\%$, 80 VDC
C-118	23089-63	Capacitor Mylar, 0.01 μf , $\pm 10\%$, 80 VDC
C-119	22041-2	Capacitor, Ceramic Variable, 9-35pf, N650
C-120	24052-220	Capacitor, Dipped Mica, 22pf, $\pm 5\%$
C-121	24052-220	Capacitor, Dipped Mica, 22pf, $\pm 5\%$
C-122	22041-1	Capacitor Ceramic Variable, 2-8pf, NPO
C-123	22041-2	Capacitor, Ceramic Variable, 9-35pf, N650
C-124	24052-220	Capacitor, Dipped Mica, 22pf, $\pm 5\%$
C-125	21555-48	Capacitor, Solid Tant., 1.0 μf , $\pm 10\%$, 35 VDC
C-126	22041-1	Capacitor, Ceramic Variable, 2-8pf, NPO
C-127	24052-270	Capacitor, Dipped Mica, 27pf, $\pm 5\%$
C-128	24049-201	Capacitor, Dipped Mica, 200pf, $\pm 5\%$
C-129	24052-270	Capacitor, Dipped Mica, 27pf, $\pm 5\%$
C-130	21291-21	Capacitor, Ceramic Disc., 1000pf, $\pm 20\%$, Z5U
C-131	23089-75	Capacitor, Mylar, 0.1 μf , $\pm 10\%$, 80V
C-132	23089-75	Capacitor, Mylar, 0.1 μf , $\pm 10\%$, 80V
C-133	21291-21	Capacitor, Ceramic Disc., 1000pf, $\pm 20\%$, Z5U
C-134	21555-18	Capacitor, Solid Tant., 22 μf , $\pm 10\%$, 15 VDC
C-135	23089-63	Capacitor, Mylar, 0.01 μf , $\pm 10\%$, 80 VDC

SYMBOL	NARCO PART NO.	DESCRIPTION
C, CAPACITORS (Continued)		
C-136	21291-21	Capacitor, Ceramic Disc., 1000pf, $\pm 20\%$, Z5U
C-137	21555-18	Capacitor, Solid Tant., $22\mu\text{f}$, $\pm 10\%$, 15 VDC
C-138	23089-75	Capacitor, Mylar, $0.1\mu\text{f}$, $\pm 10\%$, 80V
C-139	23089-57	Capacitor, Mylar, $.0033\mu\text{f}$, $\pm 10\%$, 80 VDC
C-140	21555-48	Capacitor, Solid Tant., $1.0\mu\text{f}$, $\pm 10\%$, 35 VDC
C-141	21555-48	Capacitor, Solid Tant., $1.0\mu\text{f}$, $\pm 10\%$, 35 VDC
C-142	21555-16	Capacitor, Solid Tant., $3.3\mu\text{f}$, $\pm 10\%$, 15 VDC
C-143	21555-18	Capacitor, Solid Tant., $22\mu\text{f}$, $\pm 10\%$, 15 VDC
C-144	23089-63	Capacitor, Mylar, $0.01\mu\text{f}$, $\pm 10\%$, 80V
C-145	23089-63	Capacitor, Mylar, $0.01\mu\text{f}$, $\pm 10\%$, 80 VDC
C-146	23087-17	Capacitor, Metalized Mylar, $1.0\mu\text{f}$, $\pm 10\%$, 200V
C-147	21555-18	Capacitor, Solid Tant., $22\mu\text{f}$, $\pm 10\%$, 15V
C-148	21555-18	Capacitor, Solid Tant., $22\mu\text{f}$, $\pm 10\%$, 15V
C-149	21555-18	Capacitor, Solid Tant., $22\mu\text{f}$, $\pm 10\%$, 15 VDC
C-150	2129--25	Capacitor, Ceramic Disc., 430pf, $\pm 10\%$, X5F
C-151	24052-220	Capacitor, Dipped Mica, 22pf, $\pm 5\%$
C-152	24052-820	Capacitor, Dipped Mica, 82pf, $\pm 5\%$
C-153	24052-820	Capacitor, Dipped Mica, 82pf, $\pm 5\%$
C-154	22042-2	Capacitor, Glass Trimmer, 0.8-4.5pf
C-155	21291-25	Capacitor, Ceramic Disc., 430pf, $\pm 10\%$, X5F
C-156	21296-3	Capacitor, Ceramic Feedthru, 1000pf, GMV
C-157	24052-150	Capacitor, Dipped Mica, 15pf, $\pm 1\text{pf}$
C-158	24052-301	Capacitor, Dipped Mica, 300pf, $\pm 5\%$
C-159	21291-5	Capacitor, Ceramic Disc., $.01\mu\text{f}$, $+80\%$ -20% , 25V
C-160	21296-3	Capacitor, Ceramic, Feedthru, 1000pf, GMV
C-161	24529-180	Capacitor, Ceramic Disc., 18pf, $\pm 5\%$, NPO
C-162	21555-18	Capacitor, Solid Tant., $22\mu\text{f}$, $\pm 10\%$, 15 VDC
C-165	23089-75	Capacitor, Mylar, $0.1\mu\text{f}$, $\pm 10\%$, 80V
C-166	24529-180	Capacitor, Ceramic Disc., 18pf, $\pm 5\%$, NPO
C-167	21291-25	Capacitor, Ceramic Disc., 430pf, $\pm 10\%$, X5F
C-168	21291-15	Capacitor, Ceramic Disc., $.002\mu\text{f}$, $\pm 10\%$, X5F
C-169	23089-57	Capacitor, Mylar, $.0033\mu\text{f}$, $\pm 10\%$, 80V
C-170	23089-57	Capacitor, Mylar, $.0033\mu\text{f}$, $\pm 10\%$, 80V
C-201	24049-330	Capacitor, Dipped Mica, 33pf, $\pm 5\%$
C-202	24516-339	Capacitor, Ceramic Disc., 3.3pf, $\pm 0.25\text{pf}$, NPO
C-203	24516-339	Capacitor, Ceramic Disc., 3.3pf, $\pm 0.25\text{pf}$, NPO
C-204	22019-1	Capacitor, Ceramic Variable, 0.5-4.5pf
C-205	24516-100	Capacitor, Ceramic Disc., 10pf, $\pm 1\text{pf}$, NPO
C-206	21291-25	Capacitor, Ceramic Disc., 430pf, $\pm 10\%$, X5F
C-207	21291-25	Capacitor, Ceramic Disc., 430pf, $\pm 10\%$, X5F
C-208	24516-339	Capacitor, Ceramic Disc., 3.3pf, $\pm 0.25\text{pf}$, NPO
C-209	22019-1	Capacitor, Ceramic Variable, 0.5-4.5pf
C-210	24509-518	Capacitor, Ceramic Disc., $.51\text{pf}$, NPO, $\pm 5\%$
C-211	21291-25	Capacitor, Ceramic Disc., 430pf, $\pm 10\%$, X5F
C-212	23089-63	Capacitor, Mylar, $.01\mu\text{f}$, $\pm 10\%$, 80V
C-213	22019-1	Capacitor, Ceramic Variable, 0.5-4.5pf
C-214	24516-689	Capacitor, Ceramic Disc., 6.8pf, $\pm 0.5\text{pf}$, NPO
C-215	21291-19	Capacitor, Ceramic Disc., 1000pf, $\pm 10\%$, X5F
C-216	21291-19	Capacitor, Ceramic Disc., 1000pf, $\pm 10\%$, X5F
C-217	24052-151	Capacitor, Dipped Mica, 150pf, $\pm 5\%$
C-218	24052-220	Capacitor, Dipped Mica, 22pf, $\pm 5\%$
C-219	24049-201	Capacitor, Dipped Mica, 200pf, $\pm 5\%$
C-220	24529-180	Capacitor, Ceramic Disc., 18pf, $\pm 5\%$, NPO
C-221	24049-201	Capacitor, Dipped Mica, 200pf, $\pm 5\%$
C-223	21555-48	Capacitor, Solid Tant., $1.0\mu\text{f}$, $\pm 10\%$, 35V
C-224	23089-63	Capacitor, Mylar, $.01\mu\text{f}$, $\pm 10\%$, 80V
C-225	24049-201	Capacitor, Dipped Mica, 200pf, $\pm 5\%$

SYMBOL	NARCO PART NO.	DESCRIPTION
C, CAPACITORS (Continued)		
C-226	24049-330	Capacitor, Dipped Mica, 33pf, $\pm 5\%$
C-227	24049-511	Capacitor, Dipped Mica, 510pf, $\pm 5\%$
C-228	24049-330	Capacitor, Dipped Mica, 33pf, $\pm 5\%$
C-229	23089-57	Capacitor, Mylar .0033 μ f, $\pm 10\%$, 80V
C-230	23089-75	Capacitor, Mylar, 0.1 μ f, $\pm 10\%$, 80V
C-231	23089-75	Capacitor, Mylar, 0.1 μ f, $\pm 10\%$, 80V
C-232	23089-75	Capacitor, Mylar, 0.1 μ f, $\pm 10\%$, 80V
C-233	21291-21	Capacitor, Ceramic Disc., 1000pf, $\pm 20\%$, Z5U
C-234	21555-18	Capacitor, Solid Tant., 22 μ f, $\pm 10\%$, 15 VDC
C-235	23089-63	Capacitor, Mylar, 0.01 μ f, $\pm 10\%$, 80V
C-236	21291-21	Capacitor, Ceramic Disc., 1000pf, $\pm 20\%$, Z5U
C-237	21555-18	Capacitor, Solid Tant., 22 μ f, $\pm 10\%$, 15 VDC
C-238	23089-63	Capacitor, Mylar, 0.01 μ f, $\pm 10\%$, 80 VDC
C-240	21555-48	Capacitor, Solid Tant., 1.0 μ f, $\pm 10\%$, 35V
C-241	23089-71	Capacitor, Mylar, .047 μ f, $\pm 10\%$, 80V
C-242	21555-26	Capacitor, Solid Tant., 10 μ f, $\pm 10\%$, 20 VDC
C-243	21555-48	Capacitor, Solid Tant., 1.0 μ f, $\pm 10\%$, 35V
C-244	24516-229	Capacitor, Ceramic Disc., 2.2pf, ± 0.25 pf, NPO
C-245	21291-21	Capacitor, Ceramic Disc., 1000pf, $\pm 20\%$, X5F
C-246	24516-150	Capacitor, Ceramic Disc., 15pf, $\pm 10\%$, NPO
C-247	21555-48	Capacitor, Solid Tant., 1.0 μ f, $\pm 10\%$, 35V
C-248	21555-18	Capacitor, Solid Tant., 22 μ f, $\pm 10\%$, 15 VDC
C-249	21555-18	Capacitor, Solid Tant., 22 μ f, $\pm 10\%$, 15V
C-250	21291-5	Capacitor, Cer. Disc., .01 μ f, $+80\%$ -20% , 50V, Z5U
C-251	24052-220	Capacitor, Dipped Mica, 22pf, $\pm 5\%$
C-252	24052-470	Capacitor, Dipped Mica, 47pf, $\pm 5\%$
C-253	24530-689	Capacitor, Ceramic Disc., 6.8pf, ± 0.5 pf, N ∇ 500
C-254	22042-2	Capacitor, Glass Trimmer, 0.8-4.5pf
C-255	21291-5	Capacitor, Cer. Disc., .01 μ f, $+80\%$ -20% , 50V, Z5U
C-256	21291-25	Capacitor, Ceramic Disc., 430pf, $\pm 10\%$, X5F
C-257	24516-229	Capacitor, Ceramic Disc., 2.2pf, ± 0.25 pf
C-258	21291-25	Capacitor, Ceramic Disc., 430pf, $\pm 10\%$, X5F
C-259	21296-3	Capacitor, Ceramic Feedthru, 1000pf, GMV
C-260	21296-3	Capacitor, Ceramic Feedthru, 1000pf, GMV
C-261	21291-5	Capacitor, Cer. Disc., 0.1mf, $+80\%$ -20% , 50V, Z5U
C-262	24052-121	Capacitor, Dipped Mica, 120pf, $\pm 5\%$
C-263	24052-300	Capacitor, Dipped Mica, 30pf, $\pm 5\%$
C-264	24052-240	Capacitor, Dipped Mica, 24pf, $\pm 5\%$
C-265	24052-121	Capacitor, Dipped Mica, 120pf, $\pm 5\%$
C-266	21291-5	Capacitor, Cer. Disc., .01mf, $+80\%$ -20% , 50V, Z5F
C-267	21296-3	Capacitor, Ceramic Feedthru, 1000pf, GMV
C-268	23085-66	Capacitor, Mylar, .018 μ f, $\pm 10\%$, 100 VDC
C-269	24516-150	Capacitor, Ceramic Disc., 15.0pf, 10%, NPO
C-270	24516-150	Capacitor, Ceramic Disc., 15.0pf, $+10\%$, NPO
C-270	24516-150	Capacitor, Ceramic Disc., 15.0pf, $\pm 10\%$, NPO
C-271	24529-100	Capacitor, Ceramic Disc., 10.0pf, ± 0.5 pf, NPO
C-272		Part of L-219
C-273	24516-150	Capacitor, Ceramic Disc., 15.0pf, 10%, NPO
C-274	24529-180	Capacitor, Ceramic Disc., 18pf, $\pm 5\%$, NPO
C-301	21291-5	Capacitor, Cer. Disc., .01 μ f, $+80\%$ -20% , 50V, Z5U
C-302	21291-5	Capacitor, Cer. Disc., .01 μ f, $+80\%$ -20% , 50V, Z5U
C-303	21291-25	Capacitor, Ceramic Disc., 430pf, $\pm 10\%$, X5F
C-304	24052-391	Capacitor, Dipped Mica, 390pf
C-305	24052-391	Capacitor, Dipped Mica, 390pf
C-306	21291-25	Capacitor, Ceramic Disc., 430pf, $\pm 10\%$, X5F
C-307	22042-2	Capacitor, Glass Trimmer, 0.8-4.5pf
C-308	24516-339	Capacitor, Ceramic Disc., 3.3pf, $\pm .25$ pf, NPO

SYMBOL	NARCO PART NO.	DESCRIPTION
C, CAPACITORS (Continued)		
C-309	21291-25	Capacitor, Ceramic Disc., 430pf, $\pm 10\%$, X5F
C-310	21291-25	Capacitor, Ceramic Disc., 430pf, $\pm 10\%$, X5F
C-311	21291-25	Capacitor, Ceramic Disc., 430pf, $\pm 10\%$, X5F
C-312	21291-25	Capacitor, Ceramic Disc., 430pf, $\pm 10\%$, X5F
C-313	24516-339	Capacitor, Ceramic Disc., 3.3pf, ± 0.25 pf, NPO
C-314	22042-2	Capacitor, Glass Trimmer, 0.8-4.5pf
C-315	24516-569	Capacitor, Ceramic Disc., 5.6pf, ± 0.5 pf, NPO
C-316	21291-25	Capacitor, Ceramic Disc., 430pf, $\pm 10\%$, X5F
C-317	21291-25	Capacitor, Ceramic Disc., 430pf, $\pm 10\%$, X5F
C-318	23085-71	Capacitor, Mylar, 0.047 μ f, $\pm 10\%$, 100V
C-319	21298-5	Capacitor, Cer. Feedthru, 1000pf, $+100\%$ -0% , Z5U
C-320	22030-2	Capacitor, Glass Trimmer, 0.5-7.0pf
C-321	24516-689	Capacitor, Ceramic Disc., 6.8pf, ± 0.5 pf, NPO
C-322	24507-43	Capacitor, Fixed Glass, 100pf, $\pm 5\%$, 500V
C-323	21291-25	Capacitor, Ceramic Disc., 430pf, $\pm 10\%$, X5F
C-324	21291-25	Capacitor, Ceramic Disc., 430pf, $\pm 10\%$, X5F
C-325	23085-71	Capacitor, Mylar, 0.047 μ f, $\pm 10\%$, 100V
C-326	21298-5	Capacitor, Ceramic Feedthru, 1000pf, $+100\%$ -0%
C-327	21296-3	Capacitor, Ceramic Feedthru, 1000pf, GMV
C-328	24504-33	Capacitor, Fixed Porcelain, 39pf, $\pm 5\%$, 500V
C-329	21291-25	Capacitor, Ceramic Disc., 430pf, $\pm 10\%$, X5F
C-330	24504-38	Capacitor, Fixed Porcelain, 62pf, $\pm 5\%$, 500V
C-331	21298-5	Capacitor, Cer. Feedthru, 1000pf, $+100\%$ -0% , Z5U
C-332	21291-25	Capacitor, Ceramic Disc., 430pf, $\pm 10\%$, X5F
C-333	21291-25	Capacitor, Ceramic Disc., 430pf, $\pm 10\%$, X5F
C-334	23085-71	Capacitor, Mylar, 0.047 μ f, $\pm 10\%$, 100V
C-335	21298-5	Capacitor, Cer. Feedthru, 1000pf, $+100\%$ -0% , Z5U
C-336	21296-3	Capacitor, Ceramic Feedthru, 1000pf, GMV
C-339	24504-41	Capacitor, Fixed Porcelain, 82pf, $\pm 5\%$, 500V
C-340	24516-100	Capacitor, Ceramic Disc., 10pf, ± 1.0 pf
C-341	24504-43	Capacitor, Fixed Porcelain, 100pf, $\pm 5\%$, 500V
C-342	24516-120	Capacitor, Ceramic Disc., 12pf, $\pm 10\%$, NPO
C-343	21291-25	Capacitor, Ceramic Disc., 430pf, $\pm 10\%$, X5F
C-344	23085-71	Capacitor, Mylar, 0.047 μ f, $\pm 10\%$, 100V
C-345	21298-5	Capacitor, Cer. Feedthru, 1000pf, $+100\%$ -0% , Z5U
C-346	21296-3	Capacitor, Ceramic Tubular Feedthru, 1000pf, GMV
C-347	21296-3	Capacitor, Ceramic Tubular Feedthru, 1000pf, GMV
C-348	21291-25	Capacitor, Ceramic Disc., 430pf, $\pm 10\%$, X5F
C-349	24504-19	Capacitor, Fixed Porcelain, 10pf, $\pm 5\%$, 500V
C-350	24507-31	Capacitor, Fixed Glass, 33pf, $\pm 5\%$, 500V
C-351	24504-35	Capacitor, Fixed Porcelain, 47pf, $\pm 5\%$, 500V
C-352	24504-35	Capacitor, Fixed Porcelain, 47pf, $\pm 5\%$, 500V
C-353	24504-29	Capacitor, Fixed Porcelain, 27pf, $\pm 5\%$, 500V
C-354	21291-25	Capacitor, Ceramic Disc., 430pf, $\pm 10\%$, X5F
C-355	21201-330	Capacitor, Ceramic Tubular, .33pf, $\pm 10\%$, NPO
C-356	24529-180	Capacitor, Ceramic Disc., 18pf, $\pm 5\%$, NPO
C-357	21291-25	Capacitor, Ceramic Disc., 430pf, $\pm 10\%$, X5F
C-401	23087-17	Capacitor, Metalized Mylar, 1.0 μ f, $\pm 10\%$, 200V
C-402	21555-48	Capacitor, Solid Tant., 1.0 μ f, $\pm 10\%$, 35V
C-403	21554-13	Capacitor, Electrolytic, 500 μ f, 15V
C-404	21554-11	Capacitor, Electrolytic, 200 μ f, 6V
C-405	23089-75	Capacitor, Mylar, 0.1 μ f, $\pm 10\%$, 80V
C-406	21554-21	Capacitor, Electrolytic, 1.0 μ f, 12V, NPO
C-407	21291-25	Capacitor, Ceramic Disc., 430pf, $\pm 10\%$, X5F
C-501*	21555-18	Capacitor, Solid Tant., 22 μ f, $\pm 10\%$, 15V, DC
C-503	21554-10	Capacitor, Electrolytic, 20 μ f, 35V

SYMBOL	NARCO PART NO.	DESCRIPTION
C, CAPACITORS (Continued)		
C-504	23087-17	Capacitor, Metalized Mylar, 1.0 μ f, $\pm 10\%$, 200V
C-505	23087-17	Capacitor, Metalized Mylar, 1.0 μ f, $\pm 10\%$, 200V
C-506	21554-19	Capacitor, Electrolytic, 100 μ f, 18V
C-507	21554-19	Capacitor, Electrolytic, 100 μ f, 18V
C-601	24522-1	Capacitor, Ceramic, 8 Section, .001 μ f, GMV, X5U
C-602		One Section of above unit
C-603		One Section of above unit
C-604		One Section of above unit
C-605	21291-25	Capacitor, Ceramic Disc., 430pf, $\pm 10\%$, X5F
C-606	21291-25	Capacitor, Ceramic Disc., 430pf, $\pm 10\%$, X5F
C-607	21291-25	Capacitor, Ceramic Disc., 430pf, $\pm 10\%$, X5F
C-608	21291-25	Capacitor, Ceramic Disc., 430pf, $\pm 10\%$, X5F
C-609	21291-25	Capacitor, Ceramic Disc., 430pf, $\pm 10\%$, X5F
C-610	21291-25	Capacitor, Ceramic Disc., 430pf, $\pm 10\%$, X5F

CR, DIODES

CR-101	75019-3	Diode, Silicon, Glass Case
CR-102	75013-6	Diode, Silicon, Glass Case
CR-103	75013-6	Diode, Silicon, Glass Case
CR-104	75013-6	Diode, Silicon, Glass Case
CR-105	75014-1	Diode, Germanium, Glass Case
CR-201	75019-3	Diode, Silicon, Glass Case
CR-203	75019-3	Diode, Silicon, Glass Case
CR-204	75013-6	Diode, Silicon, Glass Case
CR-205	75013-6	Diode, Silicon, Glass Case
CR-206	75013-6	Diode, Silicon, Glass Case
CR-207	75013-6	Diode, Silicon, Glass Case
CR-301	75026-1	Diode, Silicon, Glass Case
CR-302	75026-1	Diode, Silicon, Glass Case
CR-401	75205-1	Diode, Rectifier, Stud Mtg, 50 PIV, 10 Amp.
CR-501	75025-3	Diode, Zener, 11V, $\pm 5\%$, 1W
CR-502	75024-4	Diode, Zener, 33V, $\pm 5\%$, 10W, Stud MTG
CR-503	75204-49	Diode, Rectifier, 2.0 Amp., 100 PIV
CR-504	75204-49	Diode, Rectifier, 2.0 Amp., 100 PIV
CR-505	75204-49	Diode, Rectifier, 2.0 Amp., 100 PIV
CR-506	75204-49	Diode, Rectifier, 2.0 Amp., 100 PIV
CR-507*	75019-3	Diode, Silicon

FL, FILTERS

FL-101	11455-1	Filter, Bandpass, 2.5MHz(mc)
FL-201	11456-1	Filter, Bandpass, 500kHz(Kc)
FL-301	11520-101	Filter, Bandpass, 136-155MHz(mc)

I, PILOT LIGHT

I-501	12000-13	Pilot Light, 14V, #402, Red
I-502	12000-13	Pilot Light, 14V, #402, Red

J, CONNECTOR

J-502	41283-1	Connector, Coax Type UG-1051/U
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K, RELAY

K-501	65126-22	Relay, Transfer
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SYMBOL	NARCO PART NO.	DESCRIPTION
L, INDUCTORS		
L-101	11464-1	Coil, NAV. RF Input (Color Coded Black)
L-102	61451-1	Switch Sect., NAV. RF Tune
L-103	11464-4	Coil, NAV. RF Collector (Color Coded Orange)
L-104	61451-1	Switch Sect., NAV. RF Tune
L-105	11465-2	Coil, NAV. RF Output
L-106	61451-1	Switch Sect., NAV. RF. Tune
L-107	11489-1	Coil, NAV. HFIF Tune
L-108	11489-1	Coil, NAV. HFIF Tune
L-109	11488-1	Inductor, Adjustable 25 MHY NOM.
L-110	11138-5	Choke, RF. 0.47 μ hy, $\pm 20\%$
L-111	11493-2	Coil, NAV. H.F. Osc., Tuning
L-112	61430-1	Switch Sect., NAV. HFO Tune
L-113	11485-9	Choke, R.F., 0.47 μ h, $\pm 10\%$
L-201	11464-1	Coil, Comm., RF Input
L-202	61467-101	Inductor, Comm. Variable, RF Input
L-203	11464-5	Coil, Comm., R.F. Collector
L-204	61467-101	Inductor, Comm. Variable, RF Collector
L-205	11465-1	Coil, Comm., R.F. Output
L-206	61467-101	Inductor, Comm. Variable, RF Output
L-207	61468-101	Inductor, Comm. Variable, HFIF Tune
L-208	61468-101	Inductor, Comm. Variable, HFIF Tune
L-209	61468-101	Inductor, Comm. Variable, HFIF Tune
L-210	61468-101	Inductor, Comm. Variable, HFIF Tune
L-211	11485-9	Choke, RF, 0.47 μ hy, $\pm 20\%$
L-212	11493-1	Coil, Comm., HF OSC.
L-213	61475-101	Part of Comm., HFO/DBLR. PC Assy.
L-214	11138-3	Choke, RF, 0.22 μ hy, $\pm 20\%$
L-215	11138-27	Choke, RF, 0.09 μ hy, $\pm 10\%$
L-216	11485-17	Choke, RF, 2.2 μ hy, $\pm 10\%$
L-217	11485-9	Choke, R.F., 0.47 μ hy, $\pm 10\%$
L-218	11138-22	Choke, R.F., 18 μ hy, $\pm 10\%$
L-219	11198-1	Coil, Trap
L-220	11485-9	Choke, R.F., 0.47 μ h, $\pm 10\%$
L-221	11485-9	Choke, R.F., 0.47 μ h, $\pm 10\%$
L-301	61485-102	Assy., Switch, Xmitter Mixer
L-302	11507-1	Coil, RF, Mixer Input
L-304	61477-102	Assy., Switch, Xmitter, 1st Amp.
L-305	11491-1	Coil, RF, 1st Amp.
L-306	11508-1	Coil, R.F., Mixer Output
L-307	11485-3	Choke, RF, 0.15 μ h, $\pm 10\%$
L-308	61472-101	Inductor, Variable, 2nd Amp.
L-309	11503-1	Coil Assy., 2nd Amp. (Color Coded Brown)
L-310	11485-3	Choke, RF, 0.15 μ h, $\pm 10\%$
L-311	11135-9	Choke, R.F.
L-312	11503-2	Coil Assy., 3rd Amp. (Color Coded Red)
L-313	11454-1	Choke, RF, Ferrite Bead
L-315	11503-3	Coil, Assy., Driver
L-316	11454-1	Choke, RF, Ferrite Bead
L-318	11503-4	Coil Assy., Final (Color Coded Yellow)
L-319	11135-9	Choke, RF
L-320	11135-8	Choke, RF, .09 μ h
L-321	11135-9	Choke, RF
L-325	11485-18	Choke, RF, 2.7 μ h, $\pm 10\%$
L-326	11485-20	Choke, RF, 3.9 μ h, $\pm 10\%$
L-401	11667-1	Inductor, Filter, 0.15 HY
L-501	11486-1	Choke, Hash, 50 μ h
L-502	11487-1	Choke, Filter, 200 μ h

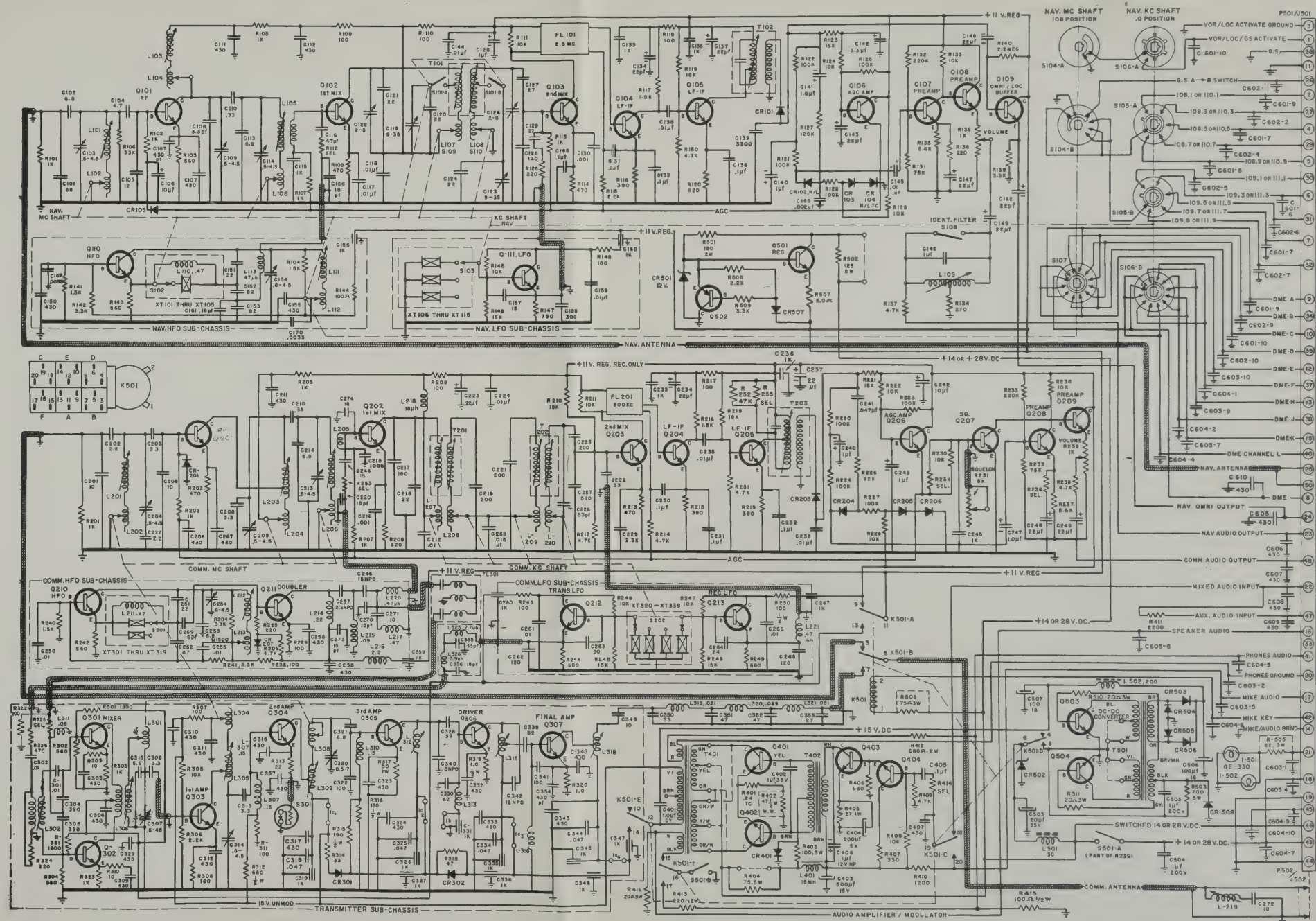
SYMBOL	NARCO PART NO.	DESCRIPTION
P, PLUG CONNECTOR		
P-501	41286-9	Connector, Plug, 50 PIN
Q , TRANSISTOR		
Q-101	75547-2	Transistor, RCA, Silicon, NPN
Q-102	75547-2	Transistor, RCA, Silicon, NPN
Q-103	75547-2	Transistor, RCA, Silicon, NPN
Q-104	75547-2	Transistor, RCA, Silicon, NPN
Q-105	75547-1	Transistor, RCA, Silicon, NPN
Q-106	75550-2	Transistor, GE 2N3391, Silicon, NPN, (Color Code White)
Q-107	75550-2	Transistor, GE 2N3391, Silicon, NPN, (Color Code White)
Q-108	75550-2	Transistor, GE 2N3391, Silicon, NPN, (Color Code White)
Q-109	75550-2	Transistor, GE 2N3391, Silicon, NPN, (Color Code White)
Q-110	75547-1	Transistor, RCA, Silicon, NPN
Q-111	75550-2	Transistor, GE 2N3391, Silicon, NPN, (Color Code White)
Q-201	75547-2	Transistor, RCA, Silicon, NPN
Q-202	75547-2	Transistor, RCA, Silicon, NPN
Q-203	75547-1	Transistor, RCA, Silicon, NPN
Q-204	75553-1	Transistor, Amperex, Silicon, NPN
Q-205	75553-1	Transistor, Amperex, Silicon, NPN
Q-206	75550-2	Transistor, GE 2N3391, Silicon, NPN, (Color Code White)
Q-207	75550-2	Transistor, GE 2N3391, Silicon, NPN, (Color Code White)
Q-208	75550-2	Transistor, GE 2N3391, Silicon, NPN, (Color Code White)
Q-209	75550-2	Transistor, GE 2N3391, Silicon, NPN, (Color Code White)
Q-210	75547-1	Transistor, RCA, Silicon, NPN
Q-211	75547-1	Transistor, RCA, Silicon, NPN
Q-212	75550-2	Transistor, GE 2N3391, Silicon, NPN, (Color Code White)
Q-213	75550-2	Transistor, GE 2N3391, Silicon, NPN, (Color Code White)
Q-301	75547-1	Transistor, RCA, Silicon, NPN
Q-302	75547-1	Transistor, RCA, Silicon, NPN
Q-303	75547-2	Transistor, RCA, Silicon, NPN
Q-304	75547-1	Transistor, RCA, Silicon, NPN
Q-305	75539-1	Transistor, RCA, Silicon, NPN
Q-306	75539-1	Transistor, RCA, Silicon, NPN
Q-307	75540-1	Transistor, RCA, Silicon, NPN
Q-401	75543-1	Transistor, RCA, 2N3054, Silicon, NPN
Q-402	75543-1	Transistor, RCA, 2N3054, Silicon, NPN
Q-403	75536-1	Transistor, RCA, 2N3053, Silicon, NPN
Q-404	75545-1	Transistor, RCA, Silicon, NPN
Q-501	75536-1	Transistor, RCA, 2N3053, Silicon, NPN
Q-502*	75561-2	Transistor, 2N3638, Silicon, PNP
Q-503	75549-1	Transistor, RCA 2N3054, Silicon, NPN
Q-504	75549-1	Transistor, RCA 2N3054, Silicon, NPN
R, RESISTORS		
R-101	31192-102	Resistor, Carbon, 1K, $\pm 10\%$, $\frac{1}{4}W$
R-102	31192-102	Resistor, Carbon, 1K, $\pm 10\%$, $\frac{1}{4}W$
R-103	31192-561	Resistor, Carbon, 560 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-104	31192-152	Resistor, Carbon, 1.5K, $\pm 10\%$, $\frac{1}{4}W$
R-105	31192-102	Resistor, Carbon, 1K, $\pm 10\%$, $\frac{1}{4}W$
R-106	31192-333	Resistor, Carbon, 33K, $\pm 10\%$, $\frac{1}{4}W$
R-107	31192-102	Resistor, Carbon, 1K, $\pm 10\%$, $\frac{1}{4}W$
R-108	31192-471	Resistor, Carbon, 470 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-109	31192-101	Resistor, Carbon, 100 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-110	31192-101	Resistor, Carbon, 100 Ω , $\pm 10\%$, $\frac{1}{4}W$

SYMBOL	NARCO PART NO.	DESCRIPTION
R, RESISTORS (Continued)		
R-111	31192-103	Resistor, Carbon, 10K, $\pm 10\%$, $\frac{1}{4}W$
R-112	31192-SEL.	Resistor, Carbon, Selected Value, $\frac{1}{4}W$
R-113	31192-102	Resistor, Carbon, 1K, $\pm 10\%$, $\frac{1}{4}W$
R-114	31192-471	Resistor, Carbon, 470 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-115	31192-222	Resistor, Carbon, 2.2K, $\pm 10\%$, $\frac{1}{4}W$
R-116	31192-391	Resistor, Carbon, 390 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-117	31192-152	Resistor, Carbon, 1.5K, $\pm 10\%$, $\frac{1}{4}W$
R-118	31192-101	Resistor, Carbon, 100 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-119	31192-183	Resistor, Carbon, 18K, $\pm 10\%$, $\frac{1}{4}W$
R-120	31192-821	Resistor, Carbon, 820 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-121	31192-104	Resistor, Carbon, 100K, $\pm 10\%$, $\frac{1}{4}W$
R-122	31192-104	Resistor, Carbon, 100K, $\pm 10\%$, $\frac{1}{4}W$
R-123	31192-153	Resistor, Carbon, 15K, $\pm 10\%$, $\frac{1}{4}W$
R-124	31192-103	Resistor, Carbon, 10K, $\pm 10\%$, $\frac{1}{4}W$
R-125	31192-104	Resistor, Carbon, 100K, $\pm 10\%$, $\frac{1}{4}W$
R-126	31192-221	Resistor, Carbon, 220 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-127	31192-124	Resistor, Carbon, 120K, $\pm 10\%$, $\frac{1}{4}W$
R-128	31192-104	Resistor, Carbon, 100K, $\pm 10\%$, $\frac{1}{4}W$
R-129	31192-103	Resistor, Carbon, 10K, $\pm 10\%$, $\frac{1}{4}W$
R-131	31195-753	Resistor, Carbon, 75K, $\pm 5\%$, $\frac{1}{4}W$
R-132	31192-224	Resistor, Carbon, 220K, $\pm 10\%$, $\frac{1}{4}W$
R-133	31192-103	Resistor, Carbon, 10K, $\pm 10\%$, $\frac{1}{4}W$
R-134	31192-271	Resistor, Carbon, 270 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-135	31192-562	Resistor, Carbon, 5.6K, $\pm 10\%$, $\frac{1}{4}W$
R-136	31192-221	Resistor, Carbon, 220 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-137	31192-472	Resistor, Carbon, 4.7K, $\pm 10\%$, $\frac{1}{4}W$
R-138	32030-7	Resistor, Variable, 1K, Audio Taper
R-139	31192-332	Resistor, Carbon, 3.3K, $\pm 10\%$, $\frac{1}{4}W$
R-140	31192-225	Resistor, Carbon, 2.2 Meg., $\pm 10\%$, $\frac{1}{4}W$
R-141	31192-152	Resistor, Carbon, 1.5K, $\pm 10\%$, $\frac{1}{4}W$
R-142	31192-332	Resistor, Carbon, 3.3K, $\pm 10\%$, $\frac{1}{4}W$
R-143	31192-561	Resistor, Carbon, 560 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-144	31192-101	Resistor, Carbon, 100K, $\pm 10\%$, $\frac{1}{4}W$
R-145	31192-103	Resistor, Carbon, 10K, $\pm 10\%$, $\frac{1}{4}W$
R-146	31192-153	Resistor, Carbon, 15K, $\pm 10\%$, $\frac{1}{4}W$
R-147	31195-751	Resistor, Carbon, 750 Ω , $\pm 5\%$, $\frac{1}{4}W$
R-148	31192-101	Resistor, Carbon, 100 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-150	31192-472	Resistor, Carbon, 4.7K, $\pm 10\%$, $\frac{1}{4}W$
R-201	31192-102	Resistor, Carbon, 1K, $\pm 10\%$, $\frac{1}{4}W$
R-202	31192-102	Resistor, Carbon, 1K, $\pm 10\%$, $\frac{1}{4}W$
R-203	31192-471	Resistor, Carbon, 470 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-204	31192-332	Resistor, Carbon, 3.3K, $\pm 10\%$, $\frac{1}{4}W$
R-205	31192-102	Resistor, Carbon, 1K, $\pm 10\%$, $\frac{1}{4}W$
R-206	31192-472	Resistor, Carbon, 4.7K, $\pm 10\%$, $\frac{1}{4}W$
R-207	31192-102	Resistor, Carbon, 1K, $\pm 10\%$, $\frac{1}{4}W$
R-028	31192-821	Resistor, Carbon, 820 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-209	31192-101	Resistor, Carbon, 100 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-210	31192-183	Resistor, Carbon, 18K, $\pm 10\%$, $\frac{1}{4}W$
R-211	31192-103	Resistor, Carbon, 10K, $\pm 10\%$, $\frac{1}{4}W$
R-212	31192-472	Resistor, Carbon, 4.7K, $\pm 10\%$, $\frac{1}{4}W$
R-213	31192-471	Resistor, Carbon, 470 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-214	31192-472	Resistor, Carbon, 4.7K, $\pm 10\%$, $\frac{1}{4}W$
R-215	31192-391	Resistor, Carbon, 390 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-216	31192-152	Resistor, Carbon, 1.5K, $\pm 10\%$, $\frac{1}{4}W$
R-217	31192-101	Resistor, Carbon, 100 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-218	31192-183	Resistor, Carbon, 18K, $\pm 10\%$, $\frac{1}{4}W$
R-219	31192-391	Resistor, Carbon, 390 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-220	31192-104	Resistor, Carbon, 100K, $\pm 10\%$, $\frac{1}{4}W$

SYMBOL	NARCO PART NO.	DESCRIPTION
R, RESISTORS (Continued)		
R-222	31192-103	Resistor, Carbon, 15K, $\pm 10\%$, $\frac{1}{4}W$
R-221	31192-153	Resistor, Carbon, 10K, $\pm 10\%$, $\frac{1}{4}W$
R-223	31192-104	Resistor, Carbon, 100K, $\pm 10\%$, $\frac{1}{4}W$
R-224	31192-104	Resistor, Carbon, 100K, $\pm 10\%$, $\frac{1}{4}W$
R-225	31192-221	Resistor, Carbon, 220 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-226	31192-823	Resistor, Carbon, 82K, $\pm 10\%$, $\frac{1}{4}W$
R-227	31192-104	Resistor, Carbon, 100K, $\pm 10\%$, $\frac{1}{4}W$
R-228	31192-103	Resistor, Carbon, 10K, $\pm 10\%$, $\frac{1}{4}W$
R-229	31192-101	Resistor, Carbon, 100 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-230	31192-103	Resistor, Carbon, 10K, $\pm 10\%$, $\frac{1}{4}W$
R-231	32030-6	Resistor, Variable, 5K, Linear Taper
R-232	31192-101	Resistor, Carbon, 100 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-233	31192-224	Resistor, Carbon, 220K, $\pm 10\%$, $\frac{1}{4}W$
R-234	31192-103	Resistor, Carbon, 10K, $\pm 10\%$, $\frac{1}{4}W$
R-235	31195-753	Resistor, Carbon, 75K, $\pm 5\%$, $\frac{1}{4}W$
R-236	31192-SEL.	Resistor, Carbon, Sel., $\pm 10\%$, $\frac{1}{4}W$
R-237	31192-562	Resistor, Carbon, 5.6K, $\pm 10\%$, $\frac{1}{4}W$
R-238	31192-472	Resistor, Carbon, 4.7K, $\pm 10\%$, $\frac{1}{4}W$
R-239	32030-4	Resistor, Variable, 1K, Audio Taper W/DPST. Switch
R-240	31192-152	Resistor, Carbon, 1.5K, $\pm 10\%$, $\frac{1}{4}W$
R-241	31192-332	Resistor, Carbon, 3.3K, $\pm 10\%$, $\frac{1}{4}W$
R-242	31192-561	Resistor, Carbon, 560 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-243	31192-101	Resistor, Carbon, 1.8K, $\pm 10\%$, $\frac{1}{4}W$
R-244	31192-681	Resistor, Carbon, 680 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-245	31192-153	Resistor, Carbon, 15K, $\pm 10\%$, $\frac{1}{4}W$
R-246	31192-103	Resistor, Carbon, 10K, $\pm 10\%$, $\frac{1}{4}W$
R-247	31192-103	Resistor, Carbon, 10K, $\pm 10\%$, $\frac{1}{4}W$
R-301	31192-182	Resistor, Carbon, 1.8K, $\pm 10\%$, $\frac{1}{4}W$
R-302	31192-561	Resistor, Carbon, 560 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-303	31192-102	Resistor, Carbon, 1K, $\pm 10\%$, $\frac{1}{4}W$
R-304	31192-561	Resistor, Carbon, 560 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-305	31192-103	Resistor, Carbon, 10K, $\pm 10\%$, $\frac{1}{4}W$
R-306	31192-222	Resistor, Carbon, 2.2K, $\pm 10\%$, $\frac{1}{4}W$
R-307	31192-101	Resistor, Carbon, 100 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-308	31192-181	Resistor, Carbon, 180 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-309	31192-100	Resistor, Carbon, 10 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-310	31192-100	Resistor, Carbon, 10 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-311	31192-101	Resistor, Carbon, 100 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-312	31141-681	Resistor, Carbon, 680 Ω , $\pm 10\%$, $\frac{1}{2}W$
R-313	31192-220	Resistor, Carbon, 22 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-314	31192-330	Resistor, Carbon, 33 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-315	31141-181	Resistor, Carbon, 180 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-316	31141-181	Resistor, Carbon, 180 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-317	31203-1	Resistor, Carbon, 50 Ω , $\pm 3\%$, 1W
R-318	31192-47C	Resistor, Carbon, 47 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-319	31149-109	Resistor, Carbon, 1.0 Ω , $\pm 5\%$, $\frac{1}{2}W$
R-320	31206-1	Resistor, Wire, 1.0 Ω , $\pm 3\%$, 1W, Non Induc.
R-321	31192-182	Resistor, Carbon, 1.8K, $\pm 10\%$, $\frac{1}{4}W$
R-323	31192-102	Resistor, Carbon, 1K, $\pm 10\%$, $\frac{1}{4}W$
R-324	31192-221	Resistor, Carbon, 220 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-325	31192-SEL.	Resistor, Carbon, Selected Value
R-326	31192-471	Resistor, Carbon, 470 Ω , $\pm 10\%$, $\frac{1}{4}W$
R-401	31187-1	Resistor, Fuse, 0.24 Ω , $\pm 10\%$, +T.C., 2W
R-402	31197-478	Resistor, Wire, 0.47 Ω , $\pm 5\%$, $\frac{1}{2}W$
R-403	31161-1	Resistor, Wire, 100 Ω , $\pm 5\%$, 3W
R-404	31162-1	Resistor, Wire, 75 Ω , $\pm 5\%$, 5W
R-405	31135-270	Resistor, Carbon, 27 Ω , $\pm 10\%$, 1W

SYMBOL	NARCO PART NO.	DESCRIPTION
R, RESISTORS (Continued)		
R-406	31192-681	Resistor, Carbon, 680Ω, ±10%, ¼W
R-407	31192-331	Resistor, Carbon, 330Ω, ±10%, ¼W
R-408	31192-103	Resistor, Carbon, 10K, ±10%, ¼W
R-409	31192-472	Resistor, Carbon, 4.7K, ±10%, ¼W
R-410	31192-122	Resistor, Carbon, 1.2K, ±10%, ¼W
R-411	31192-222	Resistor, Carbon, 2.2K, ±10%, ¼W
R-412	31200-2	Resistor, Wirewound, 680Ω, ±5%, 2W
R-413	31200-1	Resistor, Wirewound, 220Ω, ±5%, 2W
R-414	31192-SEL	Resistor, Carbon, Selected Valve, ¼W
R-501*	31200-3	Resistor, Wirewound, 180Ω, ±5%, 2W
R-502	31201-3	Resistor, Wire, 125Ω, ±5%, 8W
R-503	31201-2	Resistor, Wire, 700Ω, ±5%, 5W
R-504	31201-1	Resistor, Wire, 40Ω, ±5%, 5W
R-505	31161-2	Resistor, Wire, 82Ω, ±5%, 3W
R-506	31161-10	Resistor, Wire, 75Ω, ±5%, 3W
R-507*	31200-4	Resistor, Wirewound, 5.0Ω, ±5%, 2W
R-508*	31192-222	Resistor, Carbon, 2.2K, ±10%, ¼W
R-509*	31192-332	Resistor, Carbon, 3.3K, ±10%, ¼W
S, SWITCHES		
S-101	61424-1	Switch, Sect., NAV, HFIF
S-102	61431-1	Switch, Sect., NAV., HF OSC.
S-103	61428-1	Switch, Sect., XTAL NAV. LF OSC.
S-104	61427-1	Switch, Sect., LOC. Activate MC (Unit)
S-105	61426-1	Switch, Sect., KC GS Activate KC (Fract. Unit)
S-106	61425-1	Switch, Sect., LOC/GS/DME, KG (Fract. Unit)
S-107	61429-1	Switch, Set., DME Activate MC (Unit)
S-108	61470-1	Switch, Rotary
S-109	61452-2	Switch, Sect., NAV., HFIF, Tune
S-110	61452-1	Switch, Sect., NAV., HFIF, Tune
S-201	61462-101	Switch, PC, Comm., HFO, XTAL
S-202	61462-102	Switch, PC, Comm., LFO, XTAL
S-301	61478-1	Switch, Thermostatic
S-501		Part of R-239
T, TRANSFORMERS		
T-101	11467-1	Transformer NAV HFIF (Color Code Brown)
T-102	11461-1	Transformer NAV LFIF (Color Code Brown)
T-201	11460-1	Transformer Comm HFIF (Color Code Brown)
T-202	11460-1	Transformer Comm HFIF (Color Code Brown)
T-203	11461-2	Transformer Comm LFIF (Color Code Red)
T-401	11665-1	Transformer, Audio Output, 14 and 28V DC
T-402	11666-1	Transformer, Audio Driver
T-501	11664-1	Transformer, DC-DC Converter, 14 and 28V DC
XT, CRYSTALS		
XT-101	72007-220	Crystal, Quartz, Submin. 97.4900 108MHz(mc)
XT-102	72007-221	Crystal, Quartz, Submin. 98.4900 109MHz(mc)
XT-103	72007-222	Crystal, Quartz, Submin. 99.4900 110MHz(mc)
XT-104	72007-223	Crystal, Quartz, Submin. 100.4900 111MHz(mc)
XT-105	72007-224	Crystal, Quartz, Submin. 101.4900 112MHz(mc)
XT-106	72007-225	Crystal, Quartz, Submin. 13.0100 .0MHz(mc)
XT-107	72007-226	Crystal, Quartz, Submin. 13.1100 .1MHz(mc)
XT-108	72007-227	Crystal, Quartz, Submin. 13.2100 .2MHz(mc)
XT-109	72007-228	Crystal, Quartz, Submin. 13.3100 .3MHz(mc)
XT-110	72007-229	Crystal, Quartz, Submin. 13.4100 .4MHz(mc)

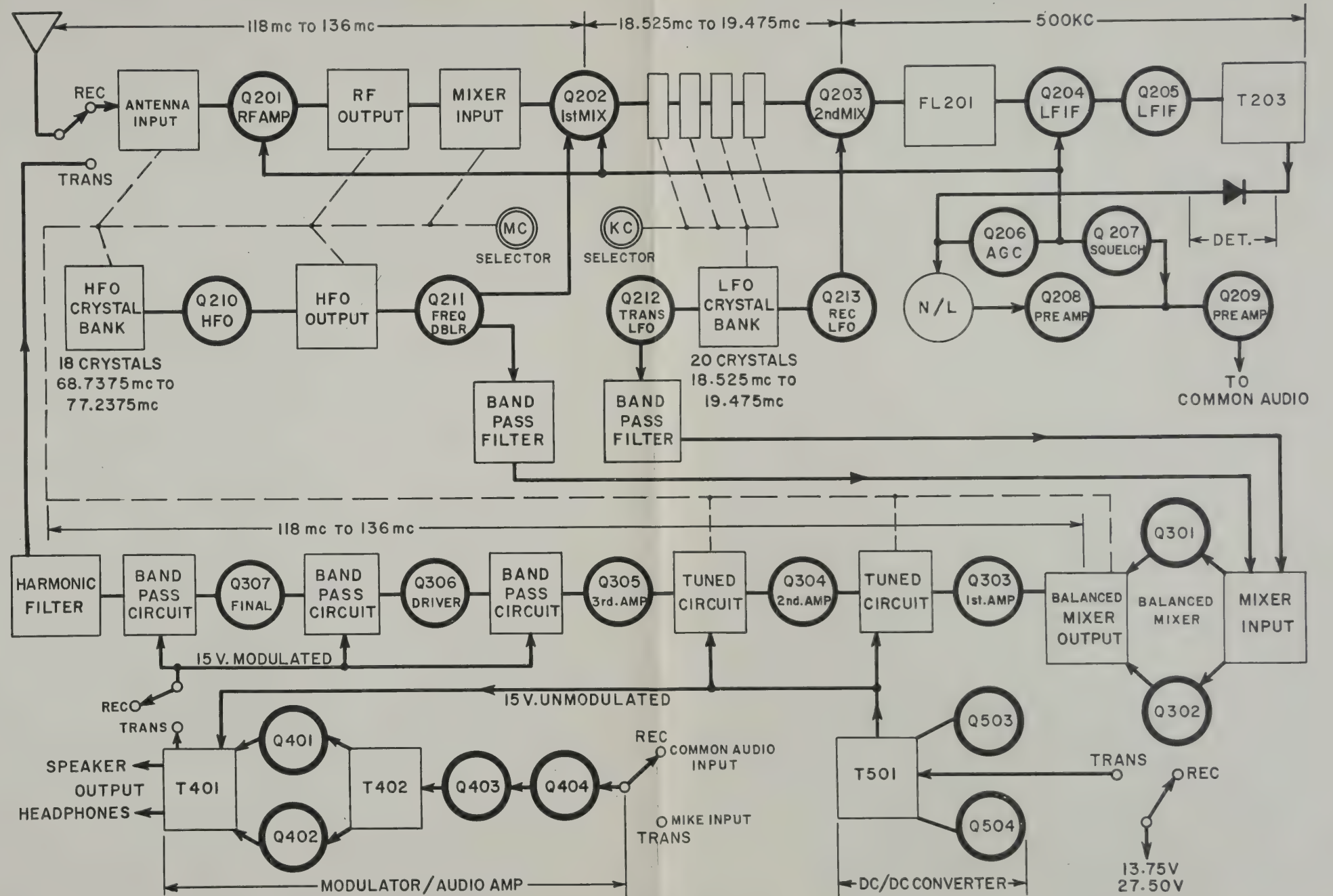
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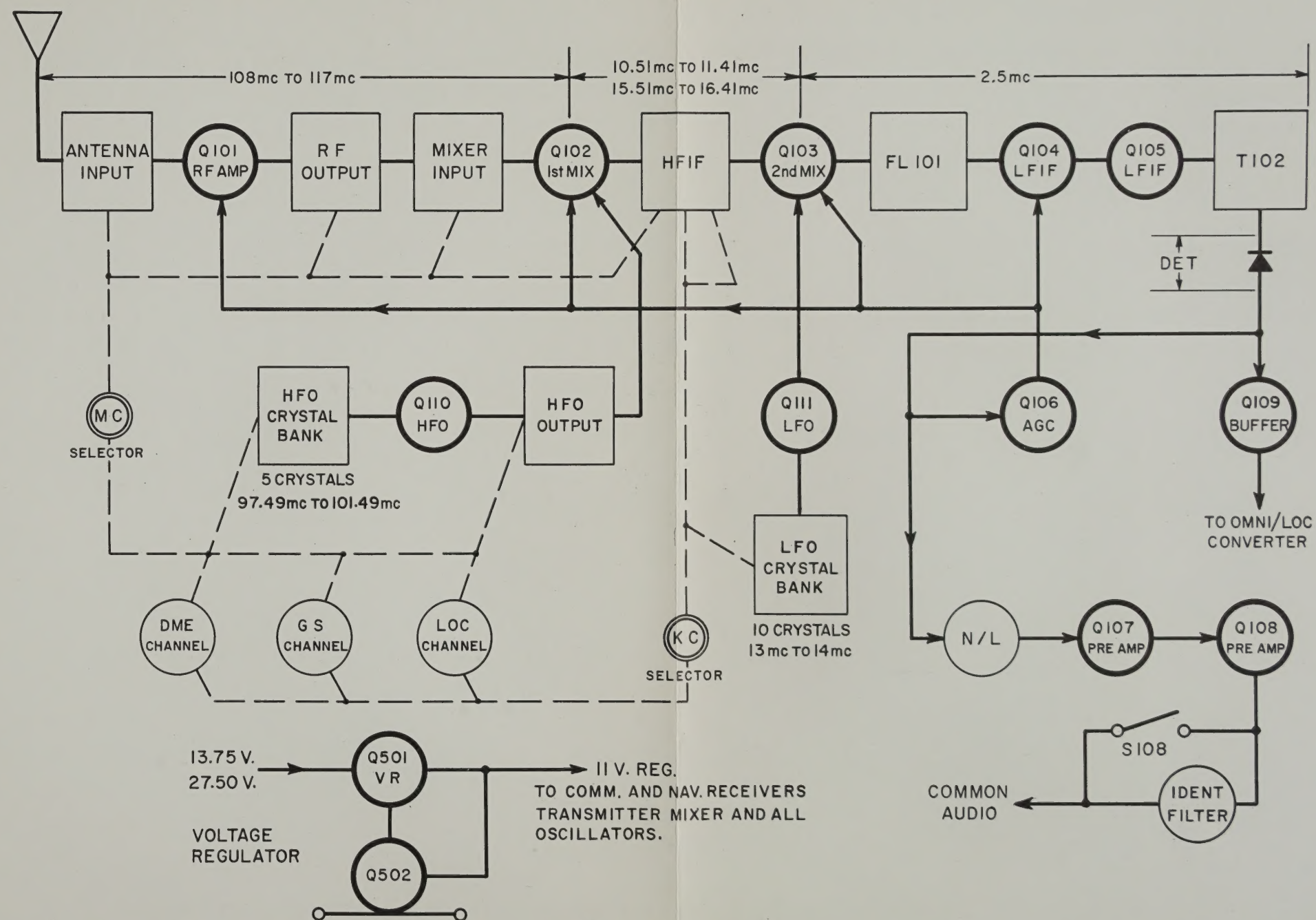
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FIGURE 7-2. narco MARK-24 SCHEMATIC DIAGRAM WITH SERVICE DATA

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